The Blast Furnace and Steel Plant

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WAGE TENDENCIES

The rapid advances made in wages in the iron and steel industry during the third quarter of last year now bid fair to be repeated during the third quarter of the present year, if the trend of average hourly and weekly earnings to May 1, 1923, is to be taken as the criterion.

At that time, according to the authoritative data compiled by the National Industrial Conference Board, the six-month period where these earnings remained near stationary had ended, and general advances, both hourly and weekly, were registered in both classes of labor—unskilled and skilled.

Blast furnaces and rolling mills taken as typical of the industry by the board in the compilation of its data numbered 17. They are distributed geographically so as to afford a fair indication of the state of the industry as a whole. At the beginning of the present year, average hourly earnings of all wage earners were 53.8 cents, as against 42.9 cents the previous year. But by May, 1923, they had risen to 58.8 cents, over the three-month period, and the same general changes are notable in the case of average weekly earnings.

The graphic charts prepared for The Blast Furnace and Steel Plant by the National Industrial Conference Board show how generally distributed over all classes and how uniform has been the gradual rise above noted.

In iron and steel plants, the varying hours of work, irregular shifts, the mixture of piece, day and tonnage work, make the compilation of wage data showing actual hours or hourly earnings exceedingly difficult. The inclusion in some cases of all the non-tonnage workers under the "unskilled" classification has the effect of raising the earnings of this labor group somewhat above the true level for strictly unskilled labor. These facts should be borne in mind when studying the hourly data for this industry.

WAGES - IRON AND STEEL INDUSTRY

UNITED STATES

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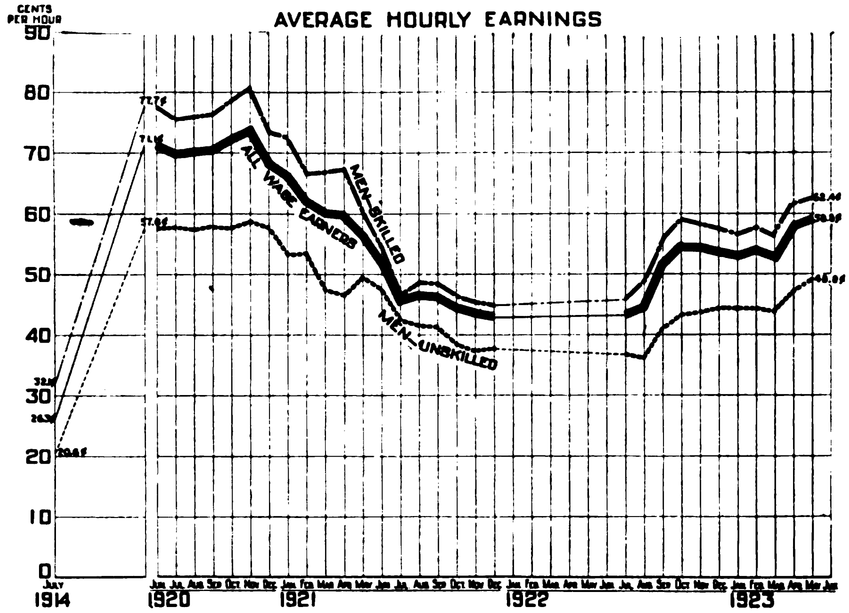
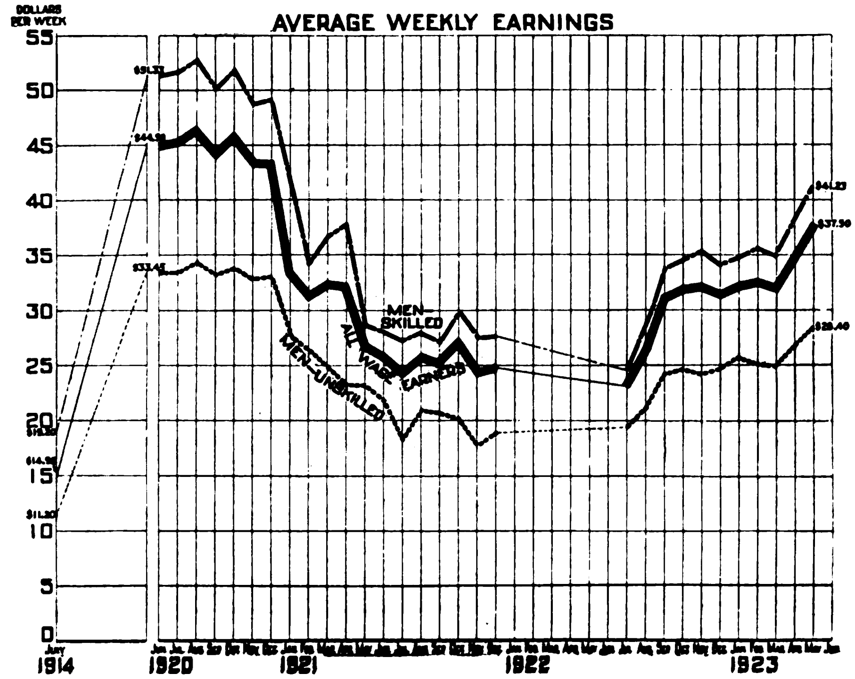
AVERAGE HOURLY EARNINGS



AVERAGE WEEKLY EARNINGS



British Views on the Ruhr Situation

Malicious Propaganda and Political Intrigue Must Ultimately Give Way to Cold Facts—A Reply to the French.

By A. C. BLACKALL*

THE British Prime Minister, Mr. Stanley Baldwin, says, in an interview:

"I feel confident that however difficult may be the problem of reparations, or any of the problems bound up with the occupation of the Ruhr, there is none in connection with which England or France may not find common ground where they can adjust one with another their mutual problems.

"The French public should realize that we feel here also the importance of the problems of the security of France and Belgium, and that we have a keen desire to effect a settlement which will guarantee for the future the maintenance of European peace. I am personally disposed to believe that very few things are impossible on condition that one is clearly conscious of the difficulties and is prepared to conquer them."

This interview has caused considerable comment, for although Mr. Baldwin has been only a short time in office, every word he utters carries conviction; he is looked upon not only as a politician but as a strong leader and a statesman of the first calibre. Mr. Baldwin's masterly handling of Great Britain's debt to America is fresh in the minds of all Americans, and stamps him indubitably as a man whose word may be absolutely trusted.

The good will he bears towards France cannot be over-estimated, and while it exists there is but small chance of any strained relationships. Instead, it seems certain that a mutual understanding may be arrived at which will ultimately tend toward the solution of the Ruhr problem and thus become a powerful factor in setting the whole European house in order. Such a condition of affairs is devoutly to be hoped for since it means a state of world prosperity which can never be achieved under existing conditions. Obviously, therefore, whatever part England plays in the Ruhr question will be anxiously watched not by European nations alone, but by the entire world, and it is highly probable that a solution agreeable to all the Allies may be found. In this connection it may emphatically be stated that Britain is prepared to make great sacrifices, and the only stumbling block would be any stiff-neckedness on the part of France.

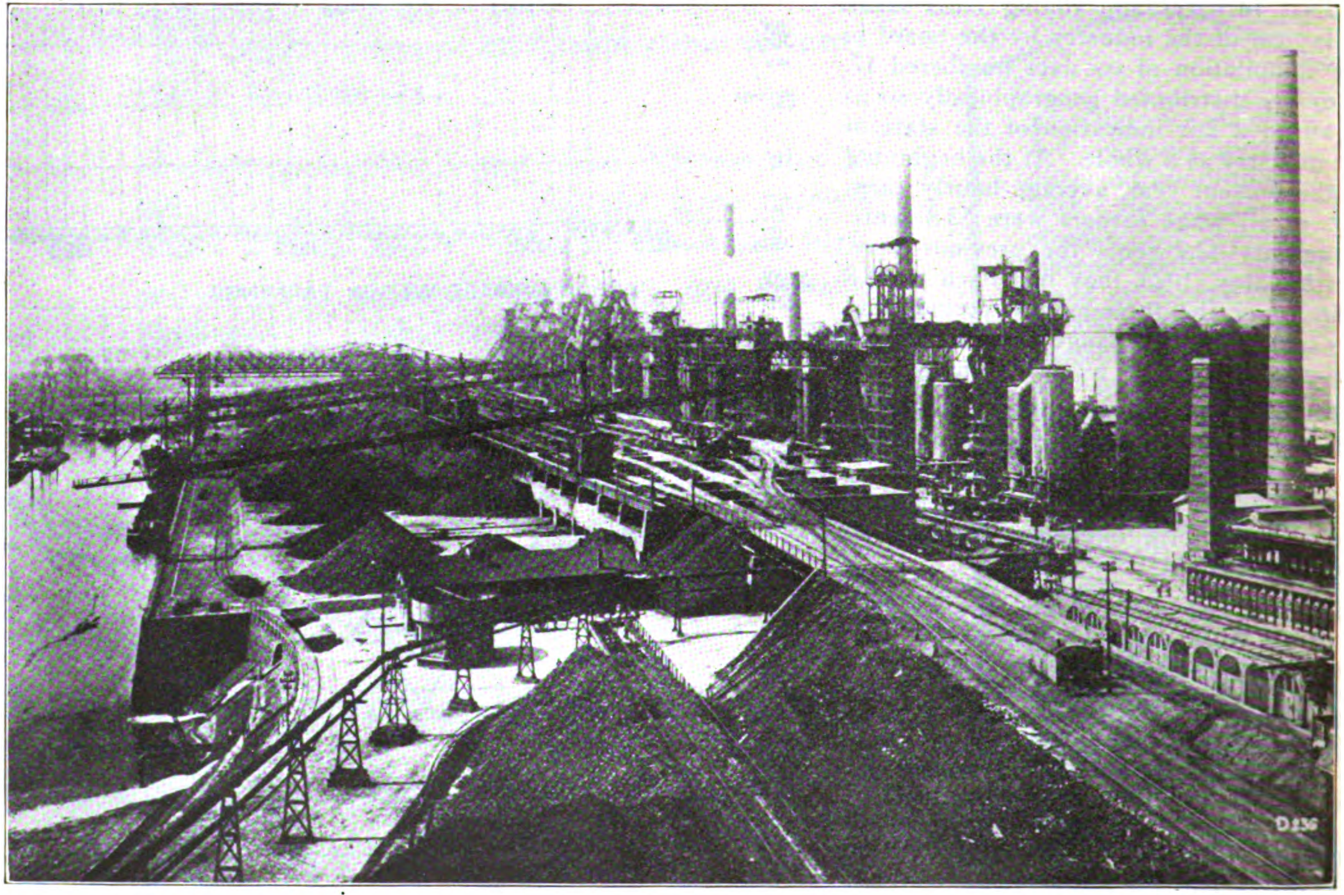


FIG. 1—*The famous Krupp works at Essen—showing blast furnaces, a corner of the by-product coke ovens, ore-bridges and unloading docks. These piles of coal are a moving cause in the Ruhr controversy.*

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*Staff Correspondent, American Trade Press, London, England.

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Rumors—they may be nothing more—are in the air that France will shortly evacuate the Ruhr, and concurrently therewith a suggestion is made favoring a compromise in which Great Britain and Italy shall be linked with France in the new negotiations about to be undertaken. In addition, it is expected that Germany will soon make another offer considerably in advance of any previously made.

It is due to these conditions and the somewhat less clouded atmosphere they induce, that the British Premier expressed such hopeful views regarding a settlement.

Thus from the very highest sources, there is direct evidence that the most strenuous measures will be brought forward to solve what is the world's most difficult problem today.

That is the political aspect. It is interesting to study the matter from other angles. It is common knowledge that the French occupation of the Ruhr has completely dislocated all classes of trade there, and that certain elements have been favoring a Franco-German combine to embrace the iron-ore and coal trades of both countries. On the other hand it can be undeniably asserted that the most powerful German combination has made definite propositions to Great Britain's largest steel and coal producers. Such a combine would naturally be a death blow to French aspirations as regards these industries, in addition to which it would undoubtedly possess a peculiarly sinister political aspect. The authority for this statement declines to have his name made public since the matter of the proposed combine is not yet definitely settled either one way or the other.

While a Franco-German combine would be unthinkable to Great Britain, so would an Anglo-German combine be equally unacceptable to France.

Notwithstanding that to some extent Great Britain's coal and metal industries have profited through the Ruhr deadlock the conditions generally are by no means satisfactory, since the trade thus generated can neither be looked upon as stable nor permanent. In fact, although coal production has increased enormously (for the week ended May 12, the output was 5,603,000 tons compared with 5,327,000 tons in the preceding week and 4,945,000 a year ago) the exports forced up to the detriment of British manufacturing interests. Customs returns show French imports for April as follows:

1,926,563 tons of coal
243,989 tons of coke
44,648 tons of briquettes

against exports

95,994 tons of coal
21,298 tons of coke
27,412 tons of briquettes.

So great have the French and German demands become that British collieries are unable at present to take any fresh orders, and it is anticipated that it will take at least another month for them to overtake arrears of deliveries.

The British steel industry has naturally been greatly affected by this condition of affairs, for instance, Sheffield buyers have been holding off in anticipation of a fall in basic steel prices; the slump has not materialized, however, and a chaotic situation has resulted in consequence. Some of the leading steel merchants, other than manufacturers, frankly state that they are puzzled by the trend of affairs. They can neither buy nor sell, and business has virtually come to a standstill. Yet the factories are working everywhere on full time, supplies of cold rolled steel are not equal to the demand, and prices seem likely to go higher. The lighter branches continue to show an improved tendency as a result of the reduced competition from Germany. These sidelights show the reason for Germany's anxiety to form an Anglo-German combine, and also to some extent explain why no definite decision has as yet been made. On every hand it is a question of awaiting the trend of events.

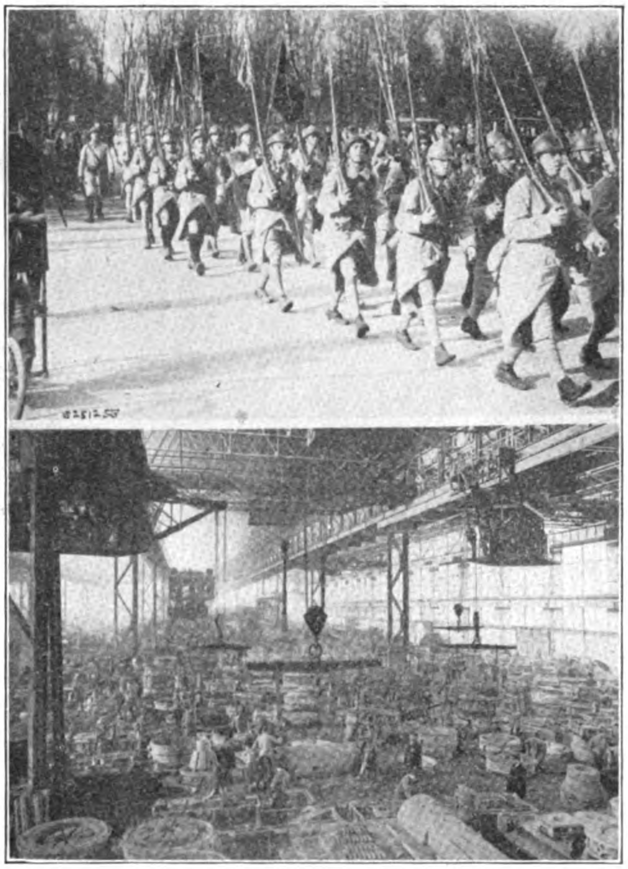
FIG. 2—*An every-day peace-time sight in the Ruhr. Below—a modern German foundry.*

It is interesting to note that the first small contract for sale to Great Britain of "minette" from Lorraine has just been concluded, and it is hoped that the trial shipment will be satisfactory to British ironmasters and be the forerunner of many more.

While the formation of a trade combine either between France and Germany, or Germany and Britain, might purely as a trade measure, be contemplated, in either case the peace of Europe again would become threatened. The long existing racial hatred between Teuton and Gaul virtually disposes of the former possibility, in addition to which France's recovery of her lost provinces and her tenacity would prove a further stumbling block to any such agreement, which, if entered into would not fail to be attended with continual friction, with suspicion ever rife on both sides. The latter proposition is equally unthinkable. The British nation as a whole would not stand for it. The hatred of Germany is almost as strong in the average Britisher as it is in the Frenchman, and such a combine with its far-reaching effects could not fail to lead to untoward events.

Sir Robert Hadfield, chairman of Hadfields Limited, and inventor of manganese steel, stated in an interview:

"It is most desirable that our country should work with France. I think it was a great pity that our soldiers did not march into the Ruhr district with those of France. Germany has had ample time to set her house in order, yet she has done nothing. Her commercial men have been making enormous profits by the falling mark, and it is indeed time to stop this farce.

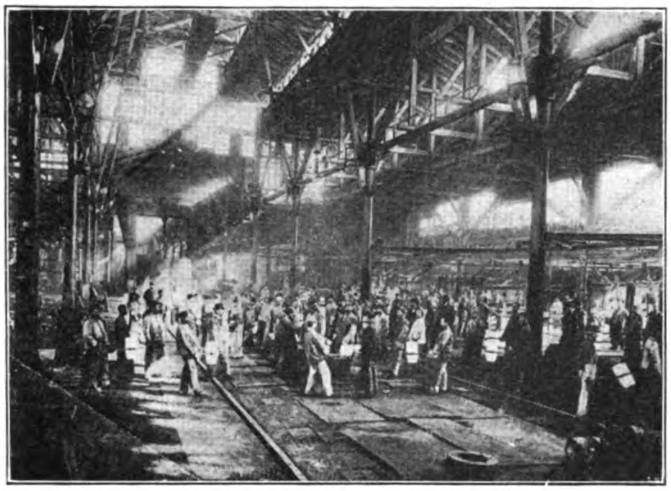

FIG. 3—*A German foundry in operation. Note the hand labor.*

"It does not seem to be recognized or known that the fight for possession of the iron ore fields of France was largely the cause of the recent war. In 1870 Germany, through the miscalculation and ignorance of her boasted scientists, obtained possession only of the Alsace-Lorraine mineral wealth; she intended to remedy this in the recent war, and failed.

"Germany knows full well that if she set about paying her debts France does not want to invade her territory. Germany promised to pay, but since Germany has not paid, she must be made to pay.

"It seems to me we shall make a great mistake if we fail to grasp the opportunity of coming to a satisfactory arrangement with France. Neither that country nor ourselves wishes to behave unfairly towards our fallen enemy, but we expect her to do what she has promised. If she won't then she must be made to do so by other means."

Turning from the political to the economic aspect, Sir Robert Hadfield said:

"The old bogey of foreign competition is being revived in the steel industry. This bogey will never be feared by any responsible steel expert. Actually the world is hungering for steel, and it is deplorable that this fact should be obscured by this old cry of foreign competition, when in point of fact the scare is needless.

"The trouble is that the public has little or no knowledge of the basic industry of iron and steel. Those who have their finger on the pulse of the industry will agree with me that foreign competition is not going to be so serious for our particular industry as some would have us believe. Now it is France and Germany who will filch our steel markets from us; in 1921 it was France and America who were suspected of this sinister design. It is always someone. In 1921 I made personal investigation of the rumors about America and France, and I ascertained that Messrs. Schneider and Cie, the principal French manufacturers had no idea of cutting our industrial throats. Neither had the American firms, such as the United States Steel Corporation, led by my colleague, Judge Gary.

"The fact is of course that no one country could possibly supply or control the whole, or even the greater part, of the world's future iron and steel requirements. Therefore the wisest industrial policy is that inaugurated by Judge Gary—live and let live. What I term industrial internationalism is not only sound sense, it is sound business. For remember that the basis of all industry is iron and steel. This is why an old Chinese proverb is constantly in my mind, 'He who owns the iron of the world rules the world.' But, no nation owns all the iron in the world, though obviously some countries produce larger quantities more cheaply than others. How, then, do the nations of the world stand in the matter of consumption and production in this industry The following figures show the iron and steel exports for 1913 of the greatest iron and steel producing nations:

Great Britain	5,000,000 tons
United States	2,750,000
Germany	5,500,000
France	500,000

For 1920, which I select as a typical after-war year, the corresponding figures were approximately:

Great Britain	3,300,000 tons
United States	4,300,000
Germany	200,000
France	827,000

"This shows that in 1920 Germany had an export surplus of only one twenty-seventh of the tonnage it used to have. But for the war, the world's production of iron and steel should by now have considerably exceeded the enormous figure of one hundred million tons. In 1920, our typical after-war year, the actual output was only some 35 per cent of this. This is one of the chief causes of the present industrial depression, for the output of iron and steel is a barometer which accurately records the progress and conditions of the world.

"The more we have of iron and steel the better for the world at large. The metal iron has a mysterious influence on us all. We could not carry on our modern life without it. The circle of its usefulness widens every year, so that when its production goes down prosperity follows suit. One of the worst effects of the recent war was that it interfered with the manufacture and output of iron and steel. These figures are instructive. They reperesent the total output of pig iron for the 10 producing countries of the world:

1913	76,000,000 tons
1920 (approximate) ..	56,000,000

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"The corresponding figures for steel were:

1913	75,000,000 tons
1920 (approximate) ..	65,000,000

"Taking these figures as substantially accurate they mean that today the world is very short of supplies of iron and steel. This shortage is a very serious matter. The development of modern civilization is hindered until increasing supplies of this important world commodity can be obtained. The difference between the exportable surplus of the four nations in 1913 and 1920 is roughly 8,000,000 tons. This is an index of the extent to which the world is suffering from steel shortage. Somebody has got to make up that deficiency. Which country can do it and overtake the world's demands? No single country nor even a group of two. It must come from all of them. The serious extent of the shortage is shown by the fact that but for the war we should doubtless have had a production of one hundred million tons in 1920. The actual production that year was about seventy million tons. All this is very alarming, for it means that the world today is short of no less than twenty-five to thirty million tons of steel. In other words, the world has to be content with only two-thirds of its actual requirements.

"The cost of steel still remains far too high, but the need continues all the same. The moment that cheaper iron and steel are available, developments of all kinds will proceed. Consider the shortage in America, where the railways require 12,000,000 tons of rails. This means roughly 76,000 miles of single line.

"Here in England we must produce more iron and steel, or else we must cut down some of the luxuries which depend on a sufficiency of iron and steel."

Mr. George Mure Ritchie, the great iron-master and director of collieries and mines says:

"Leaders of industry believe that France is taking the only step possible to secure payment by Germany and prevent a worse war, and also that she is winning, and that it is a misfortune that Britain is not acting with her."

Commenting on this Sir Robert Hadfield says:

"I agree with Mr. Ritchie that the German magnets are feathering their nests, and France had to act. I think it is very unfortunate we are not acting with her. That would, I believe, have ended the struggle. Germany would have given way.

"I particularly wish to point out that France has definitely said over and over again that she does not want to take fresh territory. She relies on the boundry line fixed by the Versailles treaty, about the same as the frontier of 1815 which Germany ruthlessly violated in 1871. My endorsement of her action is based on that promise. I believe she is sincere in making it and that she wants only to enforce the rights of her people to obtain reparation for the appalling damage done to her, and in that I believe she will succeed.

"France's stranglehold on Germany's great industrial areas is daily becoming more and more acute, and there is an almost urgent need for a proper understanding by Englishmen of the true position.

"The action in the Ruhr may well mean considerable delay in the reconstruction of Europe. It is seriously upsetting the slowly improving trade of this country. It is possible, indeed, that the effects of the occupation may be more far reaching than we can yet forsee.

"On the other hand big orders have come to this country for coal. These orders have come from Germany. While Germany is threatening all sorts of trouble and pleading poverty they are busying themselves with buying great quantities of the primary need of industry.

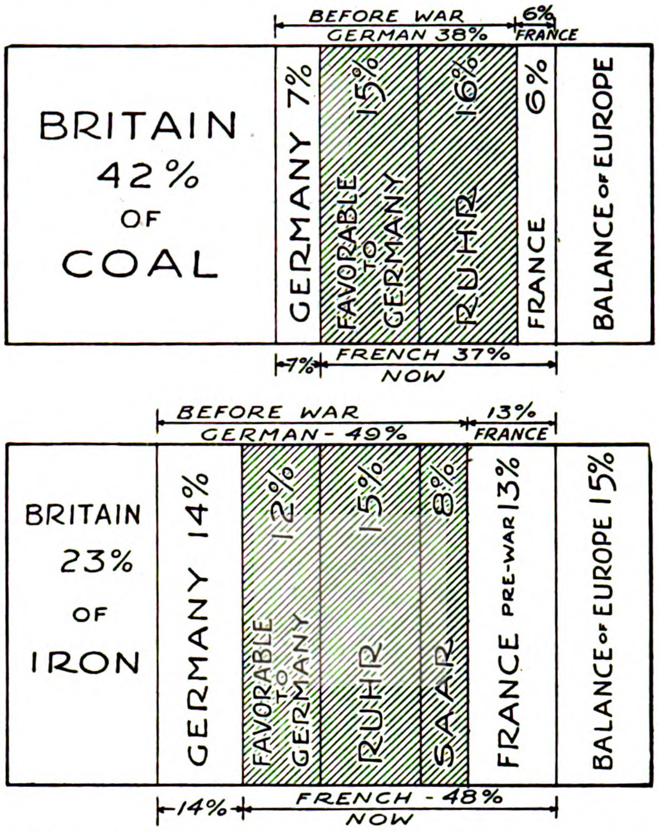

FIG. 4—*Relative economic advantages altered by the war's influence.*

"It is fairly evident that Germany is not so poor that it cannot afford to buy coal, and that her plight is not so desperate that she must close down her industries.

"Allowing for French bias, there is little proof that Germany has done anything towards the reconstruction of Europe. All the signs are that she has put the drag on progress. I am inclined to the French view, regrettable as it is, that the attitude of certain high financiers in England has encouraged the German plan of campaign. There is a danger of this influence bringing upon us unfriendly thoughts from France."

Mr. W. L. Hichens, Chairman of Cammell, Laird and Company, says:

"The amalgamation of French iron and German coal interests would be a direct advantage for Europe, because a divorce between the two is unnatural. It is obvious that there should be a close association between the coal district in the Ruhr and the iron ore of Alsace-Lorraine, and the artificial barrier imposed by political considerations is a misfortune.

"If such an arrangement were to lead to a sure basis of peace between Germany and France this country would welcome it with open arms, and would not hesitate for one moment owing to the consideration that our own iron and steel industry might be injured.

"There is room and to spare in the world for both, and there is no reason why we should be dog-in-the-mangerish and seek to ruin the prosperity of a great tract of country for selfish reasons. On the contrary, we should derive far more benefit to our trade from the prosperity of that district. Even if our iron and steel trade did suffer, we stand to gain far more by the peace of Europe and the development of those resources which will give people there greater wealth to buy, if not iron and steel, other products from us. There is no practical method by which we can cooperate with France in this amalgamation. It may be that later it will be wise to come to some arrangement limiting the output of this country and that district in order that there may not be over-production, but that is a question that can properly be dealt with by the individual industrial organizations."

In March, 1917, Germany was in possession of the French iron ore deposits in the Briey basin. Verdun was the key with which the Germans hoped to lock the door and prevent any possible recovery of the field. Dr. M. Schlenker, syndic of the Chamber of Commerce, Saarbrucken, reviewing the situation for a German technical journal gave figures showing that France in 1913 had 24 per cent of the proved reserves of iron ore in Europe against Germany's 28 per cent and 11 per cent of the world's deposits against Germany's 13 per cent. Her pre-war extraction of iron ore reached 21,500,000 tons against Germany's 36,000,000 tons and Great Britain's 16,254,000 tons.

Earlier still, in January, 1915, Dr. Schrodter reported that 80 per cent of the entire blast furnace production of France had been stopped by the war and more especially by the rapid German thrust forward beyond the Briey ore basin. In 1917 the proportion of output lost to France was reckoned at 90 per cent. Professor Max Krahmann, lecturer on Mining Economics at Berlin University, called the struggle the "Coal and Iron War of Europe" and predicted a future **real World war** in which East Asia and North America would take part, and which would have to decide definitely which coal and iron countries should take the lead in the future.

Looking to the period after the war the Ruhr magnates had but one hope and aim, and that was to hold forever the French ore basins of Briey and Longwy.

A document in Sir Robert Hadfield's possession issued during the war by the Association of German Ferro-Metallurgists dwells on the extraordinary economic importance of the French Lorraine iron basins. This demonstrated that Germany is largely dependent on foreign countries for its iron ore. The memorial urged the necessity of incorporating both the Briey and Longwy basins in the German Empire. It pointed out that **the future of the German iron industry and also of German military power would be secured thereby for a century.**

By seizing, and keeping after the war, these French deposits the Ruhr magnates hoped to secure a "good living" for 2,000,000 German workmen and their six to eight million dependents. The memorial went on to show that even agriculture and food supply would be greatly benefited because by the metallurgical treatment of the phosphorous Lorraine ores, slag could be obtained which in a powdered state was highly valuable as fertilizer. The Ruhr magnates continued:

"If France were compelled to cede to us the basins of Briey and Longwy, she would make over to us not quite one-third of her wealth of ore and Germany would have her iron deposits and hence her resources of iron doubled."

No impartial reader studying these and many other war pronouncements can doubt what the action of the Ruhr magnates would have been had Germany won, or can question the sound common sense of France in taking the only action possible to bring the Ruhr magnates, and through them industrial Germany, to heel.

The views expressed in the foregoing article, emanating as they do from leading magnates in the iron, steel and coal industries of Great Britain are more indicative of an alliance with French than German interests, and the utterances of the British Prime Minister in favor of a settlement as previously referred to, go far to confirm the possibility of such a settlement being arrived at in the not very distant future.

Structure of Alloys

The thirteenth annual May lecture of the Institute of Metals, London, Eng., was delivered on Wednesday, May 2, at Storey's Gate, Westminster, by Dr. W. Rosenhain, F.R.S., of the National Physical Laboratory.

Referring to the great accumulation of facts in regard to the properties and microstructure of alloys which have been forthcoming in recent years, the lecturer said that the time had arrived when it was most desirable that there should be found a key to this maze of knowledge in the form of a general theory that would link together the mass of facts into a homogeneous whole. Such a theory he attempted to put forward, basing it upon the intimate knowledge of crystal structure which had recently been acquired by means of the application of X-rays to the study of the arrangement of atoms in crystals. The crystal structures found in pure metals became modified in the case of alloys, particularly in those called solid solutions, where a second kind of atom, the atom of the alloying element, entered into the structure of the crystal and produced in it certain minute changes. With regard to such changes the lecturer put forward two simple principles and was then able to show a striking series of inferences from his theory, which accorded closely with a large number of experimental facts. Connections between various series of properties in metals and their alloys were established which had not formerly been recognized, such as the relation between hardness and alloying power. Especially important is the connection between the minute distortion of crystal structure which occurs in alloys and their behavior on melting and freezing, while such phenomena as plasticity, diffusion and others fell easily into line with the same type of explanation. Most important of all, perhaps, is the fact that this new theory of alloy structure affords a ready explanation of the electrical properties of metals and alloys and the changes of those properties when the metal is heated or cooled. These explanations cover the mysterious phenomena of super-conductivity found in many metals when cooled nearly to the absolute zero of temperature.

Assembling a Metallurgical Laboratory

Existing Technical Literature Contains Very Little Data of Practical Value in This Apparently Simple Problem. Space Limitation Is a Usual Error.

By **RICHARD RIMBACH***

THE author some three years ago undertook the installation of a laboratory. He searched the technical literature to find some guide as to layout, equipment and supplies necessary, but the only available literature were the descriptions of plant and research laboratories in the trade journals. These in every case were vague as to the layout and made very little mention of the equipment and supplies necessary.

In most cases the space alloted to the laboratory, its layout and equipment is left in the hands of an engineer or architect, rather than a chemist or metallurgist. In that case an inquiry is sent to supply houses as to the equipment they deem necessary. This in most cases causes the omission of apparatus and supplies, which are necessary and in many cases makes for the buying of equipment, which later cannot be used or which could have been built by the plant at a great saving of expense.

A grave error, which is as a rule committed, is the limitation of the laboratory as to size, allowing for no expansion. Generally when a company decides to have a laboratory, they allot a room or building for its use, which has outlived its usefulness or cannot be used for anything else. The furniture is of a makeshift character and the rooms are anything but attractive in appearance. This makes for work of the same character and is very discouraging to one undertaking the management of such a laboratory.

The author begs to be pardoned for an apparent breach of professional ethics in this work, namely the recommendation or the mention of material, which is special and therefore can only be obtained from certain companies. No doubt many of the ideas expressed are contrary to the experience of many who read the article, to these I will say: do not be too hasty to condemn these ideas.

Installation and Space Necessary.

A metallurgical laboratory should consist of four rooms:

1. A room for the preparation of tests and physical testing;
2. A chemical laboratory;
3. A balance room, microscopic room and office, and
4. A storage room.

The rooms should above all be light (except in the case of the storage room), large and free from dust. For this reason the laboratory should not be put too near the foundry or cleaning room, the power house or any other place where there is considerable dust; because dust not only spoils the apparatus of the laboratory, but also materially influences the accuracy of the analyses. The rooms should not be subjected to vibrations, for the analytical balances and the microscope are disturbed thereby. If it is necessary to house the laboratory in a building, which is partly used for other purposes, the basement rooms are preferable for the vibration there, is minimum.

For a laboratory with from 1-3 analysts, there should be at least 1700 square feet of floor space:

Machine shop	600 sq. ft.
Analytical laboratory	700 sq. ft.
Balance room, etc.	200 sq. ft.
Storage room	200 sq. ft.

If testing machines are not to be installed, the machine shop need only have 250 square feet; also, if the microscope is ommitted the balance room can be reduced to 150 square feet.

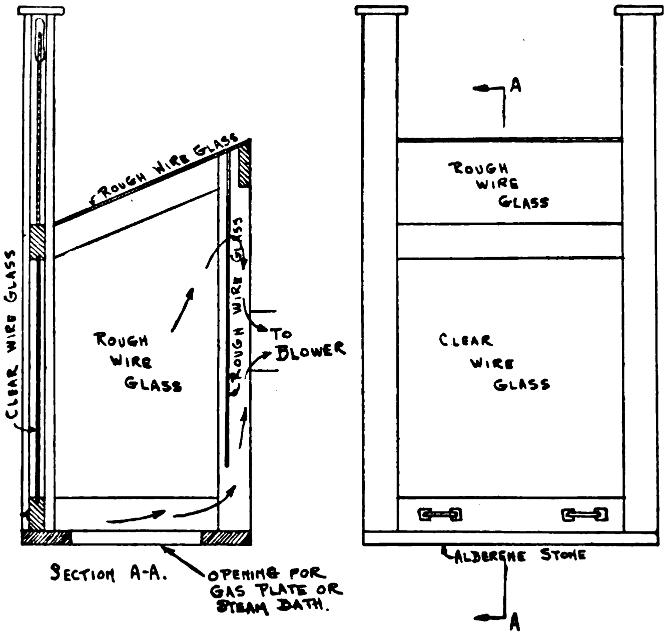

FIG. 1—*Chemical fume hood. Scale, 1 in. equals 1 ft. Made of oak, alberene stone and wire glass.*

The Machine Shop and Testing Laboratory.

The equipment of this room should be: A drill press, a shaper, a tool grinder, a work bench, and a pulverizer. If physical tests are also to be made the following equipment must also be added: A lathe, a 100,000 lb. universal testing machine, a scleroscope, a Brinell machine, a power saw, heat treating furnaces, quenching tanks, cabinets for storing tools and test pieces and miscellaneous tools including: calipers, micrometers, steel scales, etc. The machines should all be direct motor driven.

If microscopic work is to be carried on by the laboratory, a polishing machine must be added to the equipment in this room.

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*Formerly Metallurgist, Research Laboratory, Standard Steel Car Company, Butler, Pa.

The floor best suited for this room and in fact for all the rooms of the laboratory except the office, is wood block. Johns-Manville Industrial Flooring might also be used, but the wood blook is preferred by the author. Cement or concrete floors should not be considered.

The Analytical Laboratory.

Each chemist should have about 20 square feet of desk space. If the desks are set up in the room a double sided table 5 ft. wide is advisable. If set against the wall, the width found the best is 18 ins. The cupboards and drawers of the desks will serve to hold the things, which are needed daily (beakers, funnels, filter paper, etc.). The table top can be made of alberene stone (1¼ in. thick), slate, porcelain, ebonite board, polished oak or maple boards matched and set on edge or pine boards with coverings of lead-sheet (1/16 in. thick), linoleum or asbestos board (3/16 in. thick, painted with black acid resisting paint). The alberene stone will be found to give the best service in point of sanitation, cleanliness, appearance and if the length of service is considered it is also reasonable in cost. When using desks set up in the center of the laboratory, a trough can be run down the center emptying into sinks or tubs at either or both ends of the desk. If the desks are placed around the walls, sinks should be placed at convenient intervals. If alberene stone is used for the top, a groove about 4 inches wide and beginning with a depth of ¾ of an inch at the sink and tapering down to ⅛ of an inch, running along the wall will be found very useful especially in setting up for certain determinations; also when washing the top of the desk. The sinks should be large and deep (24 in. x 24 in. x 16 in).

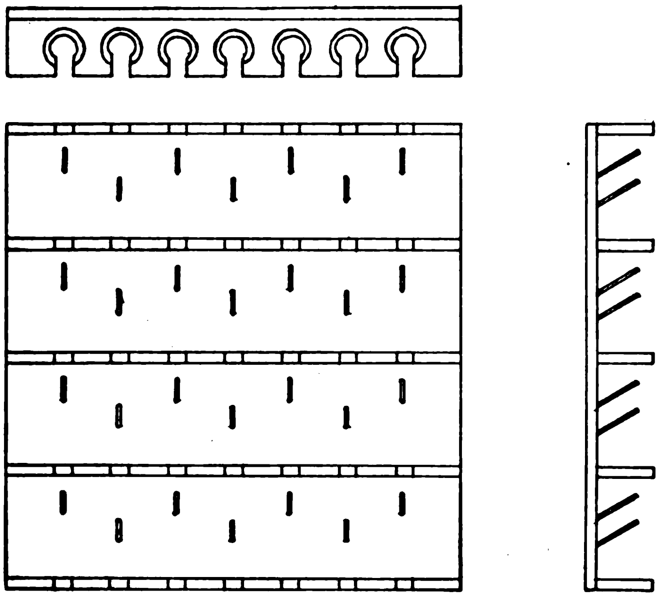

FIG. 2—*Sketch of peg-board. Will hold 28 breakers and 35 flasks at one time. Scale, 1 in. equals 1 ft.*

For each working place there should be from six to eight gas connections. Illuminating, natural or producer gas may be used. It is advantageous to have compressed air (which is available in most plants) connections, vacuum and numerous electric power plugs for the operation of motors, ovens and the like.

Between the windows, one or two shelves can be placed, directly above the tables, on which can be placed the reagent bottles, which are needed daily. The lowest shelf should be about 14 inches from the top of the table and the one above can be 14 in. from the first. The lower shelf can be made about 7 in. wide and upper 5 in. A glass plate ¼-in. thick placed on these shelves will prevent the chemicals from acting on the wood and thereby improve the appearance of the laboratory. Another shelf (heavy) about one foot wide should be placed about 6 feet above the desk, to carry the large bottles containing the reagents used as washes, also distilled water and the standard solutions. These reagents can be siphoned down to the table top with the aid of glass and rubber tubing. This is also clearly shown in one of the figures.

Sections of the desks should be set aside for sulphur and arsenic determinations, calorimeters, or filtering and others for carrying on titrations.

The fumes should be taken out of the laboratory by a hood. If sufficient space is available, it can be placed in the center of the laboratory, thereby being made accessible from all sides; otherwise the hoods can be placed against the wall. The sides and top should be made of glass. The front should be arranged so that it can be closed by windows. The hoods should have from two to six compartments. The sketch of one compartment is given in Fig. 1. The gas hot plate should be set flush with the desk top in one of these compartments. In another compartment of the hoods a stream or wash bath can be set up. Other compartments can be used for hydrogen sulphide apparatus, and for the testing of fuels, oils and gases. All hot acid solutions should be kept under the hoods, and in this way the atmosphere of the laboratory can be kept free from acid fumes. The hood unit here shown is provided with a draft by means of the outlet in back. In some cases the natural draft is sufficient for sucking off the gases, but it is generally necessary to suck off the gases by an exhauster.

To clean the beakers, flasks, etc., hot water should be provided. A drain and peg board will also materially assist in this regard. The sketch of such a board developed in the author's laboratory is shown in Fig. 2.

A large cabinet should also be provided to hold the seldom used chemicals and the glass or porcelain held in reserve. This cabinet as well as the desks and hoods can be constructed in the plant carpenter shop.

For carrying on electrolytic analyses a special desk should be provided. The arrangement used in the author's laboratory was similar to that illustrated in Price and Meade "Technical Analysis of Brass." A single unit only was constructed of wood in place of alberene stone. Compressed air was blown through the solution to speed up the determination. The current necessary is direct current of about 20 volts. If direct current is available in the laboratory this can be converted to the lower voltage by using resistances. High voltage alternating current must be transformed into direct current of low voltage by generators or rectifiers, the choice of which depends on local conditions. Storage battery current may be used.

A shower bath head should be placed in the laboratory for estinguishing burning clothing or for diluting corrosive liquid splashes. It should be provided with a chain fastened to a quarter turn valve so that the water may be released without difficulty in time of accidents. No drain need be provided in the floor, as the use of this shower should be infrequent. Fire extinguishers and sand pails should also be provided in case of fire. The author has found a first-aid cabinet of material assistance in dealing with burns, cuts, etc.

The service is best piped above the tables and in the hoods. The piping system can comprise drains, hot, cold and distilled water, compressed air, vacuum, gas, high and low pressure steam and direct and alternating current electricity. All piping, if exposed is easily accessible in case repairs are necessary. The author suggests painting all pipes and fittings with distinctive colors denoting their use. A suggested color scheme is given below:

Service.	Color for Pipe.	Color for Fittings.
Acetylene	Black	Different colors for
Compressed Air	Yellow	Black
Electricity	Black	Black different currents and voltages.
Gas	Blue	Gray
Hydrogen	Blue	Blue
Oxygen	Yellow	Yellow
Pyrometers	Black	Yellow
Steam, high pressure	Brown	Brown
Steam, low pressure	Brown	Black
Steam, exhaust, drips	Brown	Green
Steam, heating system	Brown	Bronze
Vacuum	Green	Green
Water, cold	White	White
Water, hot	White	Black
Water, distilled	Glass	Rubber
Water, fire	Red	Red
Waste and Sewage	Gray	Gray

Waste pipes and drains should be duriron. The service, which is not exposed, should be carried in a trench in the floor, which runs down the center of the laboratory, and should be constructed so that it is easily accessible.

Balance Room and Office.

The balances can be set up on a wall shelf or on a balance table, the top of either should be made of birch strips, matched and glued.

The microscope is an important feature of the modern laboratory and if one is to be installed, provision must be made for setting it up. To complete the equipment of this room there should be a desk, chairs, a bookcase, file cases and a cabinet for storing valuable instruments and apparatus.

Storeroom.

It is advisable to have this room arranged similar to the storerooms in the plant, that is nothing should be drawn out of this room without making a record of it. After the laboratory has been in operation for sometime, the person having charge of this room will know the amounts of the different supplies which will have to be kept on hand.

The still for distilled water can very handily be set up in this room.

The storeroom can also be made to serve as a dark-room in case of necessity.

CHEMICAL LABORATORY APPARATUS

Alberene stone tops and sinks or tubs	
*Asbestos sheet, 1/8" thick.	
Balance, Industrial Laboratory Model..........	1
" Ainsworth Analytical (only 1 necessary in a very small lab.)................	2
" Baker's scale	1
†Balance, Covers (piece of oil cloth large enough to cover the balances)	
Beakers, low form with lip, 1000 cc.............	1 case
" tall form with lip, 600 cc..............	1 case
" tall form with lip, 300 cc..............	1 case

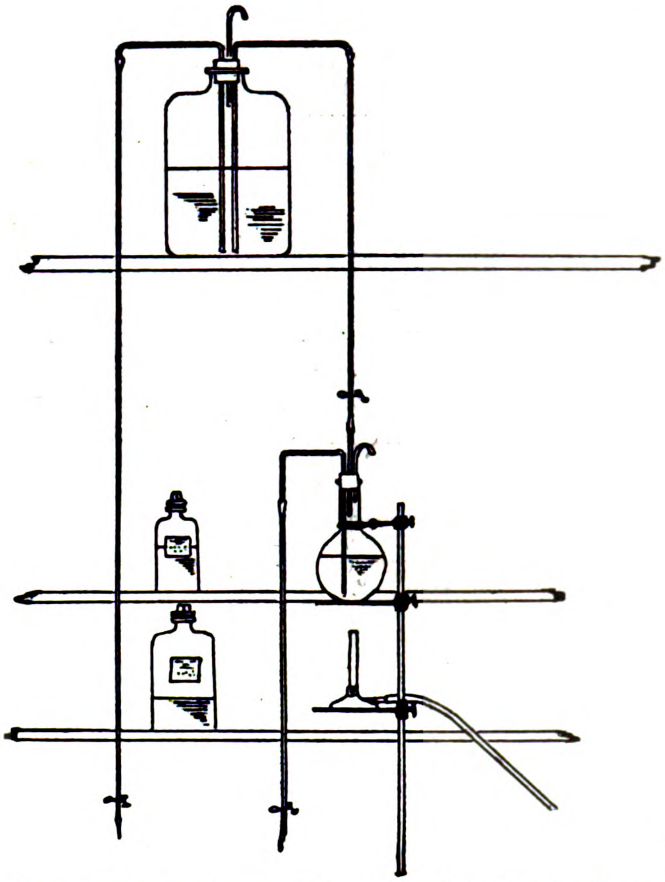

FIG. 3—*Hot and cold wash water for analytical work. The apparatus shown above has the advantages over the ordinary hot water wash bottle, in that the only attention required is the refilling of the large storage bottle. The force of the washing stream is supplied by gravity, no blowing is necessary. This apparatus can also be used for hot and cold acid and alkali wash solutions. In the case of alkali solutions a soda lime guard must be placed in the place of the bent tube on the large storage bottle.*

Blower, exhaust 2,000 cu. ft. per min. acid resistant with direct connected motor....	1
Bulbs, modified Fleming mercury sealed absorption	3
Boats, combustion, vitrified clay................	40
*Bottles, 5 gallon for distilled water and reagents	24
" dropping for indicators 1 oz...........	3
" reagent, flat glass stopper, 1000 cc.....	24
" reagent, flat glass stopper, 500 cc.....	24
" reagent, salt mouth, 1000 cc...........	12
" reagent, salt mouth, 500 cc...........	12
" reagent, salt mouth, 250 cc..........	6
" weighing, F.B. ground in glass stopper	2

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*Items with this mark can generally be drawn from plant storerooms and can therefore be requisitioned as needed.

†Items with this mark can be constructed by the plant or laboratory mechanical department.

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Brushes, burrette	6
" camel hair	4
" narrow tubing	12
" test tubes	2
* " wooden handle for washing glassware.	6
Burners, Bunsen	8–12
" evaporating 4-6"	2–3
" blast	1
Burner wing top for Bunsen burner	1
Burrettes, two-way stop cocks, 100 cc	4–6
" two-way stop cocks, 50 cc	4–6
" Johnson's for quickly measuring reagents	4-6
‡Calorimeter	1
Casseroles, porcelain, 2000 cc	2
" porcelain, 750 cc	24
" porcelain, 375 cc	6
‡Centifuge, electric (Phos. determinations and paint analysis)	1
†Clamps, burrette	
" universal for condenser with fastener	2
" Mohr's pinch-cock tubing, medium	24
" Caddock's for beakers, medium	2
" Bunsen, with fasteners, large	6
† " for test tubes or flasks (wood)	6
Condensers, glass, Leibig with inner tube sealed	2
Corks, various sizes	1 lb.
Cork borers	1 set
*Crocks, 3 gallon	6
Crucibles, porcelain with cover, 95 cc	6
" silica, platinum shape, 30 cc	12–24
" porcelain, Gooch stationary bottom 50 cc	12–24
" light wrought iron with cover, 100 cc	6
" platinum with cover, 30 cc	1–2

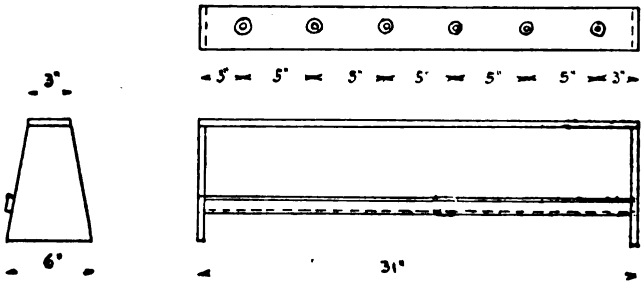

Figure 4. Funnel Stand for 6 Funnels.

Dessicators, 8" diam. inside	2-6
" 6" diam. inside	1–2
†Dessicator plates. (See Fig. 5.)	
dishes, nickel, 3" diam	2
†Electrolytic apparatus.	
*Files, triangular, 8"	2
Flasks, Erlenmeyer, 500 cc	1 case
" Erlenmeyer, 1000 cc (for wash bottles)	6
" Erlenmeyer, filtering, 1000 cc	6-12
" volumetric, glass stoppered, 50 cc	2–6
" " " " 100 cc	2–6
" " " " 250 cc	2–6
" " " " 500 cc	2–6
" resistance glass, distilling with side tube in center of neck, 500 cc	6
‡Flash point tester	1
Funnels, glass, long stem, 60° angle 3½" diam.	12–48
" glass, long stem, 60° angle, 6" diam, ribbed	2–6
" separatory, pear-shaped, 1000 cc	2–6
" separatory, long stem, 50 cc	6–12
" Walter's for 50 cc Gooch crucibles	2–6
†Funnel supports for 6 funnels each. (See Fig. 4)	2–4
†Funnel supports for 2 funnels each	2–4
†Furnace, electric, carbon combustion, single-tube	2

It is best to buy one of these furnaces and then to construct the other in spare time.

Furnace, electric for ignitions, 8"x12"x6"	1
Gas generator, Kipp's, small	1

‡These items should be omitted if oils, paints, fuels, water or gas are not analyzed.

Gauges, mercury pressure	2–3
* " constant pressure. (As used in welding outfits.)	1
Graduates, conical, 1000 cc	2
" " 500 cc	2
" " 100 cc	2
" " 50 cc	2
" " 10 cc	2
‡Gas collecting bottles	4–6
Gas washing bottles, 100-125 cc	4–6
Hot plate, electric, 12"x18"	1
† " " gas, any desired size	1
† " " steam, any desired size	1
Hydrometer for light liquids, Baume & Sp. Gr.	1
Hydrometer for heavy liquids, Baume & Sp. Gr.	1
Magnet, 6"	1
Mortar, and pestle, porcelain, 6"	1
" " " tool steel	1
" " " agate 3"	1
‡Nessler jars, 50 cc, matched	6–12
‡Orsat apparatus	1
Oven, electric, constant temperature drying, medium size	1
Pipettes, 1 cc	1–2
" 2 cc	1–2
" 3 cc	1–2
" 5 cc	1–2
" 10 cc	1–2
" 25 cc	1–2
" 50 cc	1–2
Platinum wire, No. 26 gauge	6"
" anode gauze cylinder	1–2
" cathode gauze cylinder	1–2
Pencils, wax, for marking glass	6
Porcelain plate, 12 cavities	1
Pump, vacuum, single stage, water cooled with motor	1
Pyrometer for electric furnaces with 3 couples and leads	1
Rings, support, 3" diam	6
Rings, support, 4" diam	6
†Ring stands, ⅜" rod, 18" long	6
†Ring stands, ⅜" rod, 36" long	6
Rod, glass, ¼" diam	12–24 ft.
Scoop, weighing with counterpoise, 30 cc	1
Sieves, 20 mesh to 200 mesh	1 set
Spatula, steel blades, 4"	2
" porcelain, spoon at one end, 6"	2
Still, automatic, 1 gal. per hour. (Type of still depends on the water available)	1

Stoppers, rubber:

Number	7	6	5	3	2	0
No hole	1 lb.	1 lb.	1 lb.	½ lb.	½ lb.	¼ lb.
One hole	1 lb.	1 lb.	1 lb.	½ lb.	½ lb.	
Two hole	1 lb.	2 lb.	2 lb.			

†Test tube support for 12 tubes	1
Thermometers, 10 to 360° C.	2
Tongs, crucible, nichrome, double bent, 9"	6
Tongs, crucible, nichrome, double bent, 20"	2
Triangles, nichrome, 1⅛" sides	6
‡Tubes, Goetz phosphorus	6–12
‡Tubes, 50 cc, used for paint analysis	6–12
Tubes, fused silica glazed on inside, tapered at one end, 1⅛" diam., 30" long	3
Tubing, glass, ¼" outside diam	50 ft.
Tubing, glass, ⅜" outside diam	24 ft.
" rubber, heavy wall, red, ⅛" inside diam.	30 ft.
" rubber, heavy wall, red, ¼" inside diam.	10 ft.
U-tubes, glass-stoppered with side arms, 6"	12
‡Viscosimeter, Saybolt, standard universal with stop watch	1
Washing bottles for combustion train	3
Watch glasses 6" diam	12
" " 5" "	12
" " 4" "	12
" " 3" "	12
" " 1⅛" "	12
" " balance, counterpoised 2½" diam.	1 pair

Weights, analytical, 1 mg. to 200 gm.	1 set
” analytical, 1 mg. to 100 gm., heavy gold plated	1 set
” commercial, brass, 1 gm. to 1 kg.	1 set
” commercial, brass, ¼ oz. to 4 lbs.	1 set

CHEMICALS

Acetic Acid, Glacial, 99.5%	5 lbs.
Acetic Anhydride, C. P.	1 ”
Acetone, C. P.	1 ”
Alumina, levigated, grade No. 2	1 ”
Aluminum Foil, C. P.	¼ ”
Aluminum Potassium Sulphate, C. P.	½ ”
Alundum RR 60 mesh	5 ”
Alcohol, Denatured	1 gal.
” Methyl 95%	5 ”
” Ethyl 95 U. S. P.	1 ”
Ammonium Acetate, C. P.	½ lbs.
” Bisulphate, C. P.	½ ”
” Carbonate, C. P.	1 ”
” Chloride, C. P.	½ ”
” Hydroxide, C. P. 0.90	40 ”
” Nitrate, C. P.	1 ”
” Oxalate, C. P.	1 ”
” Persulphate, C. P.	5 ”
” Phosphate, C. P., secondary	½ ”
” Sulphocyanate (Thiocyanate) C. P.	½ ”
Amyl Acetate, C. P.	½ ”
Antimony, metallic, powd. C. P.	¼ ”
Arsenous Acid, C. P. powd.	¼ ”
Asbestos, med. fibre, washed in acid and ignited.	1 ”
Ascarite	2 ”
Barium Carbonate, C. P.	1 ”
” Chloride, C. P.	1 ”
” Hydroxide, C. P.	1 ”
Benzol (Benzine) C. P.	2 ”
Borax, commercial	1 ”
Boric Acid, 99%	1 ”
Bromine, liquid, N. F.	¼ ”
Cadmium Chloride, C. P.	2 ”
Calcium Carbonate, C. P.	1 ”
” Chloride, desiccators	5 ”
” ” 12 mesh, anhyd. for drying	1 ”
” ” 20 mesh, anhyd. for drying	1 ”
Carbon Tetrachloride, C. P.	1 ”
” Bisulphide, C. P.	1 ”
Cedar oil for immersion	1 oz.
Chromic Acid, C. P. Cryst.	1 lbs.
Citric Acid, C. P. cryst.	½ ”
Chloroform, pure, U. S. P.	1 ”
Collodion, U. S. P.	1 ”
Copper Ammonium Acetate, C. P.	½ ”
” ” Chloride, C. P.	½ ”
” Chloride, C. P. (cupric)	1 ”
” Oxide, C. P. granular	¼ ”
” Sulphate, C. P. cryst.	1 ”
Cotton, absorbent	1 ”
Dimethylogloxime, C. P.	¼ ”
Ether, U. S. P.	5 ”
Eschka's Mixture	1 ”
” Chloride, C. P.	1 ”
Ferric Chloride, C. P. Phos. Free	1 ”
Filter Paper, qualitative 15 Cm. diam.	100 sheets
” ” quantitative 15 Cm. diam.	5000 ”
Formic acid, 25% pure	1 lbs.
Glass wool	1 ”
Hypophorus acid, U. S. P. 30%	1 ”
Hydrochloric acid, C. P. 1.19	120 ”
Hydrofluoric acid, C. P. 48%	¼ ”
Hydrogen Peroxide, 3%, U. S. P.	1 ”
Iodine Crystals, resublimed, C. P.	¼ ”
Iron Sulphate lumps	10 ”
” Wire for standardizing	¼ ”
Lead Acetate, C. P.	½ ”
” Chromate, C. P.	½ ”
” Nitrate, C. P.	½ ”
” Oxide, C. P. red	½ ”
” Test Granular	1 ”
Litmus, purified	1 oz.
” Paper, neutral	6 tubes
Magnesium Chloride, C. P.	½ ”
” Oxide, C. P. heavy	½ ”
” Sulphate, C. P. cryst	½ ”
Manganese Sulphate, C. P. cryst.	1 lbs.
Matches	12 boxes
Mercuric Chloride, C. P.	½ lbs.
” Oxide, red, U. S. P.	½ ”
Mercurous Nitrate, C. P.	½ ”
Mercury, metallic	2 ”
Methyl Orange	1 oz.
Molybdic Anhydride, C. P. 100% acid	5 lbs.
Nitrose-Beta-Napthal	1 oz.
Nitric Acid, C. P. 1.42	140 lbs.
” ” fuming	2 ”
Oxalic Acid, C. P.	1 ”
Oxygen, as used in welding	2 tanks
Paraffine	1 lbs.
Perchloric Acid, 1.12, C. P.	¼ ”
Phenolphtalein	1 oz.
Phosphoric Anhydride	1 lbs.
Picric Acid, C. P.	1 ”
Potassium Bichromate, C. P.	1 ”
” Bisulphate, C. P.	½ ”
” Chlorate, C. P.	2 ”
” Chromate, C. P.	½ ”
” Cyanide, C. P.	1 ”
” Ferricyanide, C. P.	1 ”
” Ferrocyanide, C. P.	1 ”
” Hydroxide, C. P. by Alc. Sticks	2 ”
” Iodate, C. P.	½ ”
” Iodide, C. P.	1 ”
” Nitrate, C. P. cryst.	2 ”
” Nitrite, C. P. cryst.	1 ”
” Permanganate, C. P. cryst.	1 ”
” Sulphate, C. P.	½ ”
” Sulphide, C. P.	½ ”
” Thiocyanate, C. P.	¼ ”

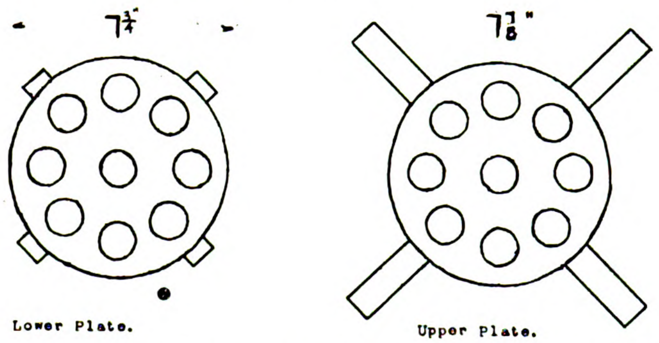

FIG. 5—*Dessicator plates. These plates can be made of sheet iron 1/16 in. thick. Porcelain plates are only arranged to hold 7 crucibles. These plates are made to hold 9 crucibles each and two plates (an upper and a lower) can be used in each 8-in. dessicator; thus increasing the capacity of each dessicator for 7 crucibles with the porcelain plate to 18 with these plates. The tabs shown in the diagram are bent down before putting the plates into the dessicator.*

Pyrogallic Acid	1 ”
Sand, quartz, washed and ignited	1 ”
Shellac	½ ”
Silver Nitrate, C. P.	¼ ”
Sodium Acetate, C. P.	½ ”
” Arsenite, C. P.	1 ”
” Ammonium Phosphate, C. P.	½ ”
” Bicarbonate, C. P.	1 ”
” Bismuthate, C. P.	1 ”
” Bisulphite, C. P.	½ ”
” Carbonate, C. P. cryst.	1 ”
” Carbonate, +. O. anhyd.	½ ”
” Chlorate, C. P.	1 ”
” Chloride, C. P. cryst.	1 ”
” Hydroxide, C. P. sticks, electrolytic	2 ”
” Hyposulphate, C. P. (Thiosulphate)	1 ”
” Nitrate, C. P.	1 ”
” Oxalate, C. P.	1 ”
” Peroxide, C. P.	½ ”
” Potassium Tartrate, C. P. cryst.	½ ”
” Phosphate, C. P. secondary	1 ”
” Sulphate, C. P. dry	1 ”
” Sulphide, C. P.	½ ”
” Sulphite, C. P.	½ ”
Stannous Chloride, C. P.	½ ”

(Continued on page 431)

The Cooling of Pig Iron

Present Rate of Cooling Can Be Raised, with Decrease of Initial and Operating Costs.

By **LEWIS H. MILLER**[*]

THE purpose of this analysis is to show how pig iron in the process of manufacture can be cooled at a rate higher than that from machines in general use. An application of such an improvement decreases the initial and operating cost of pig machines as well as the distance between the ladle and the loading track.

The rate of heat transmission has been under investigation both from the experimental and theoretical side for many years. Few empirical formulae have been developed and these are applicable to certain conditions, namely, those involving metal to metal, gases and liquids separated by a metallic wall and conductor insulation coverings. Little is known about the rate at which heat is transmitted from molten iron coming directly in contact with water. Therefore, in the absence of such data, the subject will be treated analytically, concluding with something relative.

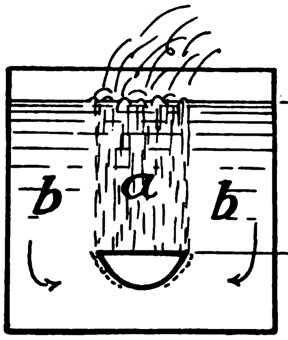

FIG. 1.

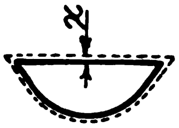

FIG. 2.

FIG. 1—*A molten pig immersed in water.*
FIG. 2—*A film of water surrounding pig.*

The internal conductivity of heat through still water is very slow; hereinafter represented by C. It is inappreciable in gases. Metals, such as iron, offer a much better conductance, but in this case its rate can be neglected. The internal thermal resistance k is the reciprocal of the conductivity $\frac{1}{c}$.

The temperature of the molten iron will be represented by T^1 equal to 245 deg. F. In this case we will consider cooling the pig to a point below solidification, say, to a black red heat, equal to 1000 deg., represented by t. 70 deg. F. equals T represents the temperature of the atmosphere and the water, x the thickness of the liquid, Q the rate of heat transfer in thermal units, 0.150 the specific heat of the pig, and 110 lbs. the weight of one pig.

It is here seen that the heat emitted necessary to reduce the temperature of the pig from 2450 to 1000 deg. is equal to 0.15 (2450 — 1000) 110 = 23,925 Btu. This is the required amount of heat to evaporate

$$\frac{23925}{(212-70)+970.4} = 21.5 \text{ lbs. of water from 70 deg.}$$

at atmospheric.

If it were possible to immerse a molten pig into a vessel of still water containing about 20 gal. (168.5 lbs.) to a depth of x, as in Fig. 1, we would have a generation of hot water on the sides of the iron and rising to the surface in a direct path—a. We would have an immediate slow internal convection of heat in the path of a and a slower conduction of heat in the outside, b, b. The continuance of this would cause the particles of b to move about and then to form a confused circulation of cold water down the sides of the vessel and up through the center. The liberation of heat would be caused by the latent heat of evaporation taking place at the bounding surface between the pig and the water. It would take just 23,925 Btu. to raise the temperature of the water to the boiling point without evaporating any nor figuring other losses, and the time it takes would be proportional to the rate of heat transfer. As a matter of fact, ebullition starts as soon as the pig is immersed and the heat content of the pig could not be transferred to the water without loss through latent heat of evaporation. While ebullition goes on and as the temperature of the water increases the rate of heat transfer approaches in direct proportion the difference in temperature between the iron and the atmosphere, the thermal conductivity and inversely to the depth x. This is analagous to the Rankine formula $Q = \frac{T^1 - T}{kx}$.

Rankine has found that "the rate of external conduction through the bounding surface between the solid body and a fluid is approximately proportional to the difference in temperature, when that is small; but when that difference is considerable, the rate of conduction increases faster than the simple ratio of that difference." It here follows that we assume the difference to be "considerable." Then Q is equal to or greater than $\frac{T^1 - T}{kx}$. If we take $T^1 - T$ and k as constants for any one instant we would have, R is equal to or greater than $\frac{1}{x}$, or the rate of transfer would be inversely proportional to the depth x.

Suppose that instead of immersing the molten pig into water we apply a film of water on the surface as in Fig. 2. Representing the rate of heat conductivity by R is equal to or greater than $\frac{1}{x}$ we readily see that by reducing x we can increase the rate R infinitely.

It follows that there will be increased dissipation of heat due to rapid generation of steam, which verifies the statement by Clark "that the absorption of heat through metal plates is more active whilst evaporation is in progress—when the circulation of the water is more active—than while the water is being heated up to the boiling point." It will be noted that instead of absorption of heat through metal plates we have substituted another medium—water.

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[*] Otis Steel Company, Cleveland, Ohio.

We will have accomplished three things if we maintain a thin film of water on the surface of the pig, namely, (1) reduced the thickness of the liquid, (2) applied a medium to the bounding surfage which acts as a dissipating agent as well as a conductor, (3) increased the circulation by rapid evaporation and instant ebullition, all of which tends to increase the rate of cooling.

It is now evident that to get the highest rate of cooling we must apply water continually in films. As the pig lays in the mold it is only possible to spray the top surface. It is difficult to ascertain the correct film thickness to apply on such a varying indefinite surface to be most effective in reducing the time while traveling the shortest distance up the incline. The most practicable method to employ is the installation of transverse (of the chain) spray pipes at increasing distances apart, each regulated by a valve. For the installation the cross pipes should be placed at the same minimum distance apart and the variable distance determined by opening and closing the valves.

Referring to Fig. 3 cross pipes are spaced at ab less than bc less than cd less than de less than ef less than fg less than gh ......, spraying water on the pigs moving in the direction of the arrow at a uniform speed. By spraying a film of water as thin as practicable on the first pig No. 1 it will be evaporated by the time it reaches position No. 2. The pig will be reduced in temperature equivalent to $T^1 - D\,T^1 = T_2$. In passing under spray b the pig receives another film of water at the same temperature and at the same film thickness and will become evaporated upon reaching position No. 4—the pig being reduced in temperature equivalent to $T_2 - D\,T_2 = T_3$. In passing under spray c the pig receives another film of water at the same temperature and at the same thickness (quantity) as before and will become evaporated upon reaching position No. 7—the pig being reduced in temperature to $T_3 - D\,T_3 = T_4$...... The reason for these increasing distances or increasing intervals is that each interval the temperature of the pig has been reduced and that of the water kept constant, which reduces the rate of transfer as will be seen by examining the equation $Q = \frac{T^1 - T}{kx}$. Therefore, to apply another film or quantity of water before the first has been evaporated would only interfere and retard the rate of conduction.

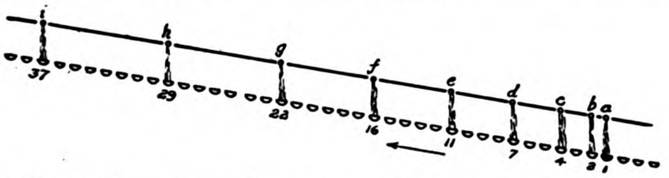

FIG. 3—*Cross pipes so located that spacing constantly reduces.*

High guards along the side should not be constructed, as this would not allow the vapor to blow away immediately after arising from the intense bubbling. An added advantage might be had by installing pipes along one side, emitting compressed air at a low pressure for the purpose of increasing vapor circulation.

A Warning to Americans

Dr. Arthur A. Hammerschlag, economist and educator, has an important message for the American manufacturer, for the small business man and for the individual worker.

In a most prophetic address before the Co-operative Club of Pittsburgh, at the William Penn Hotel, July 17, he turned the searchlight of Europe's best opinion upon the self-complacency of America.

"Americans are living in a fictitious heaven of their own creation. Untouched by storms raging in other parts of the civilized world, they fail to see the ripples of approaching disillusionment."

Dr. Hammerschlag, recently returned from European capitals, dwelt upon the plans of financial control and rehabilitation in the various commercial countries.

Dr. A. A. Hammerschlag

"England has met her wartime responsibilities by providing for ultimate liquidation through carefully prepared budgets.

"Holland has followed a like conservative policy and her investors, always heavy purchasers of American securities, stand aloof at our failure to set our own financial house in order. Just why America has failed to apply simple economic principles to governmental activities—just why American corporations have insisted upon enormous expansion of capital issues—no one can comprehend. Enormous increases in Federal, state and municipal taxation have not resulted in more careful expenditures of the money so raised."

When Dr. Hammerschlag speaks it is well to listen.

Without economy, rigidly adhered to, there will be no competition possible in world markets for our exportable surplus.

The American "standard of living" will need revision downward.

Coke Quality and Blast Furnace Operations

Heat Economy and Furnace Capacity—A Review of the Work of Heinrich Koppers.

By **F. W. SPERR*** and **D. L. JACOBSEN†**

PART III

NUMBER two above brings up the question of the relation of coke consumption to the overall heat economy of a blast furnace plant. In Koppers' opinion, the blast furnace should not be operated as a gas producer, but should be operated in such a way as to use the minimum quantity of fuel required to reduce the ore and produce iron of good quality. This is best accomplished by the use of fast burning coke. With such coke, a minimum quantity of air is required and so less gas is needed for heating the blast and less power is needed for the blowers per ton of pig iron and the producing capacity of the blast furnace is increased. In Table 1 of Howland's data, it is seen that the carbon consumption ranges from 2,251 pounds to 1,423 pounds per ton of pig iron. The air requirement varies between 80,100 cu. ft. and 141,600 cu. ft. per ton of pig iron.

With fast burning coke and consequent decreased coke consumption, the ratio of CO_2 to CO in the furnace gas rises. The heating value of the gas goes down somewhat, but is always ample for gas engine operation, for boiler heating or for the operation of regenerative furnaces.

A blast furnace using properly prepared coke should produce a ton of pig iron with about 1176 pounds of carbon gasified with air before the tuyeres. In the plants investigated by Howland, the better operating furnaces gasify 123 pounds of carbon per square foot of hearth cross section per hour. This means the production of 0.114 tons of pig iron per square foot of hearth cross section per hour. The production of the blast furnace rises with increasing cross section of the hearth and in Koppers' opinion, it is not impossible, using coke of proper quality, to attain the "American Goal," viz. a production of 1,000 tons of pig iron per blast furnace per day. (See Fig. 11.)

In the discussion, a point of objection was raised to the use of fast burning coke because it was claimed that the temperature obtained would not be so great as when using slow burning coke. For example, in high temperature furnaces where refractory materials are to be melted, the densest possible fuel is chosen. In answer to this, it was pointed out by Koppers and by Meissner that in blast furnace operation, it is not a matter of producing an intensely high local temperature, but of supplying a large quantity of heat at a rapid rate. The fuel must, moreover, be gasified in such a way as to avoid the formation of a large oxi-

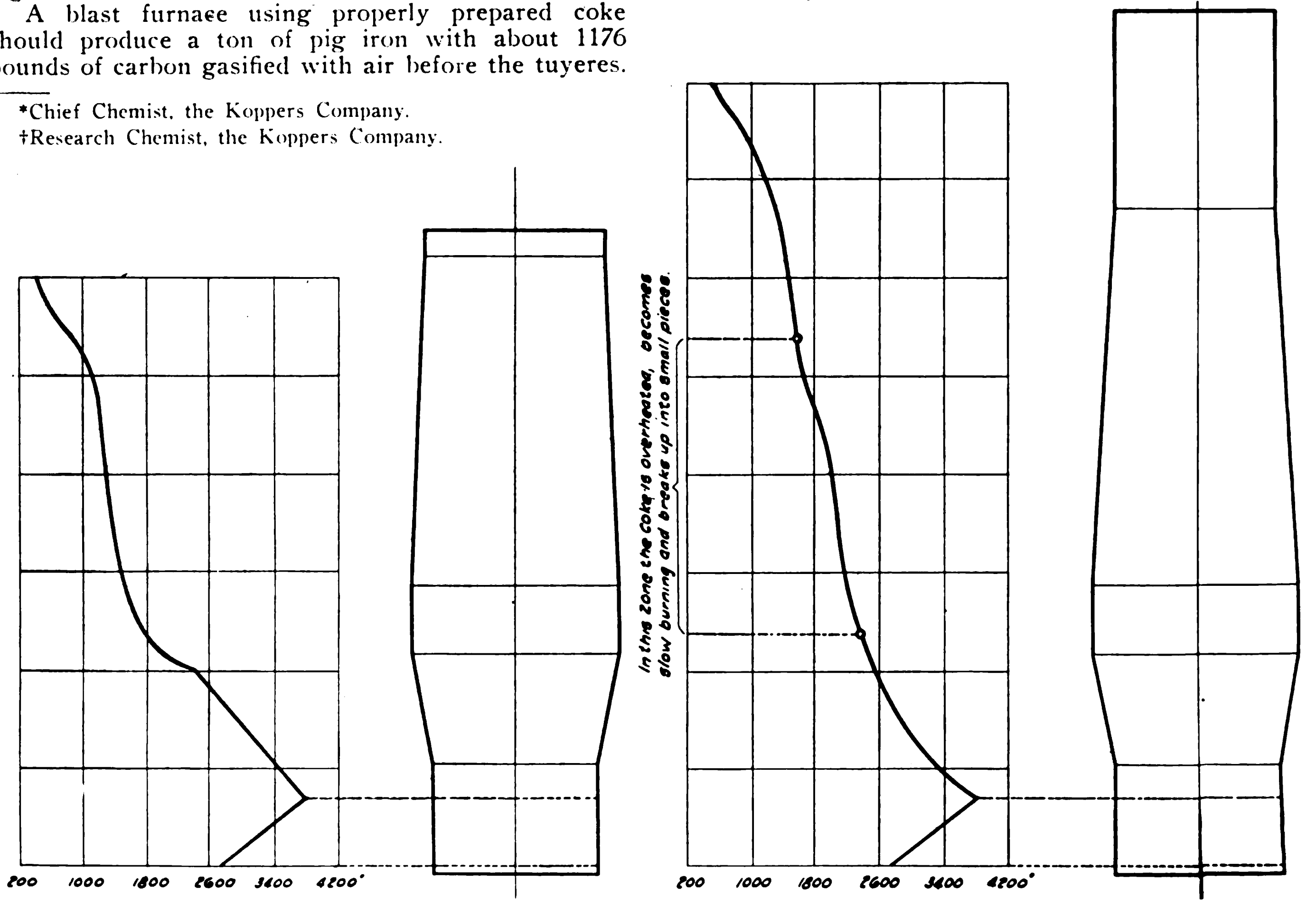

FIG. 9—*The usual temperature profile of the blast furnace.*

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*Chief Chemist, the Koppers Company.

†Research Chemist, the Koppers Company.

dizing gas zone. The temperature attainable with fast burning coke is entirely adequate and much more favorable conditions are obtained by the increased rate of gasification.

According to Gillhausen—Experiment 3

Heating value of 1 cu. ft. of furnace gas = 105.9 Btu.

Heating value of 122,700 cu. ft. furnace gas = 12,993,930 Btu.

Average heat capacity up to 1830 °F..

	Btu. per °F.
For ascending materials	2716
For descending materials	2128
Excess heat per °F.	588

$$\frac{CO_2}{CO} = 0.46 \qquad \frac{CO}{CO_2} = 2.16$$

According to Gillhausen—Experiment 4

Heating value of 1 cu. ft. furnace gas = 124.4 Btu.

Heating value of 162,000 cu. ft. furnace gas = 20,152,800 Btu.

Average heat capacity up to 1830 °F.

	Btu. per °F
For ascending materials	3494
For descending materials	2348
Excess heat per °F.	1146

$$\frac{CO_2}{CO} = 0.24 \qquad \frac{CO}{CO_2} = 4.11$$

According to Howland—Furnace 19

Heating value of 1 cu. ft. of furnace gas = 88.54 Btu.

Heating value of 112,300 cu. ft. furnace gas = 9,944,165 Btu.

Average heat capacity up to 1830 °F.

	Btu. per °F.
For ascending materials	2492
For descending materials	1693
Excess heat per °F.	799

$$\frac{CO_2}{CO} = 0.64 \qquad \frac{CO}{CO_2} = 1.56$$

Heat of evaporation of moisture is not taken into account.

Fast Burning Coke and Difficultly Reducible Ores.

A further point was made that while fast burning coke might give good results with easily reducible ore such as Mesaba ore, slower burning coke might have to be used for the more difficultly reducible ores that have to be smelted in many German plants. In reply to this, Koppers expressed the opinion that commonly accepted views as to easily reducible and difficultly reducible ores need investigation and revision. The so-called difficultly reducible ores such as Swedish ore are hard and dense and are commonly introduced into the blast furnace in too large pieces, which practice makes trouble not only on account of the difficulty of reducing the ore in such form but also because uniform distribution of the materials cannot be obtained. Such ores should be crushed before charging and the denser the ore, the more it should be crushed. Reference is made in this connection to Simmersbach's work on coke consumption in the blast furnace. Simmersbach found an actual decrease of coke consumption resulting from increasing the proportion of difficultly reducible ores (magnetic ores) in the burden. At the conclusion of his article, Simmersbach said, "In smelting difficultly reducible ores, the coke consumption can be lowered if enough heat is available at the tuyeres for direct reduction." In Koppers' opinion, this statement is absolutely correct but it is only true when the coke is fast burning, for which slow burning coke, in spite of the higher temperature, the available heat is to a large extent used up in the secondary reduction of the oxide compounds formed in the oxidizing zone.

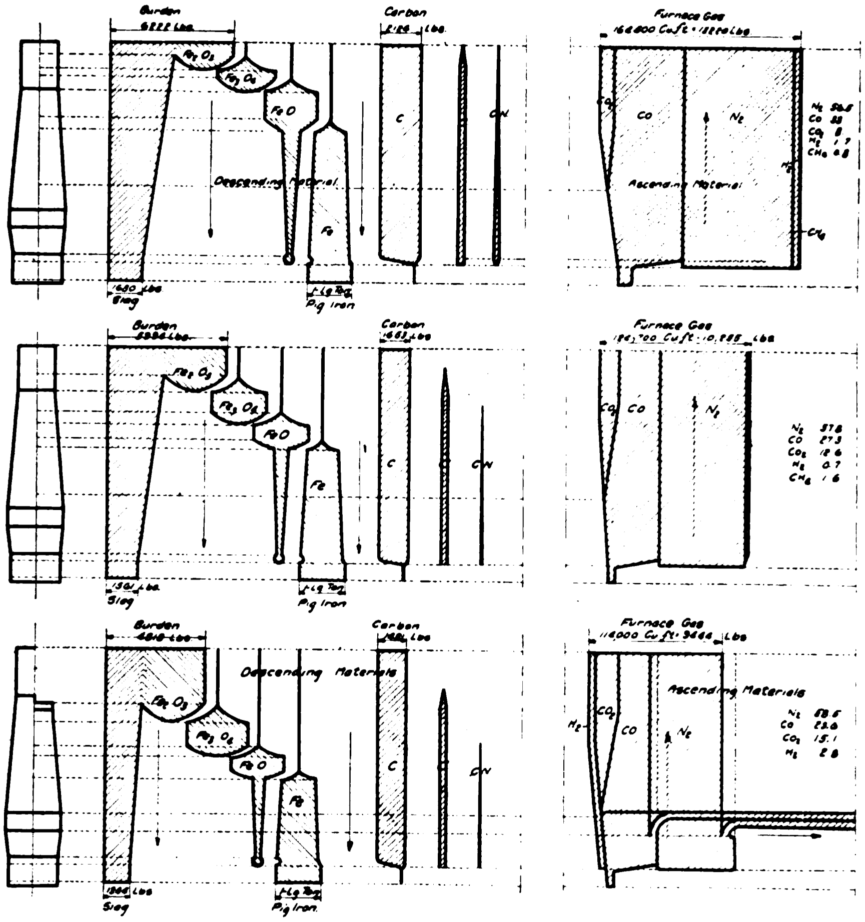

FIG. 10—*Studies of the material of the blast furnace.*

Other Recommendations.

Other conditions desirable for good blast furnace operation are enumerated. It is important that the coke reach the blast furnace in pieces of the right size and it should possess sufficient strength so that it will not be broken up on its passage through the shaft. These properties can be obtained by proper selection and mixing of coals. After the coke is pushed, it should be handled in such a way that the natural breakage will occur. Coal pieces larger than 4¾ in. should be broken down. The breeze should be carefully screened out. Uniformity in the size of blast furnace coke is very essential in order to secure good distribution in the furnace. Next in importance to the preparation of the coke is that of the burden, materials of which should be broken to suitable size. It is also desirable to dry the materials and remove the dust.

Koppers also proposes an arrangement by which the molten iron and slag would be held at a constant level in the blast furnace, the metal and slag being run off continuously. It is his opinion that with the avoidance of the usual fluctuations of level a more uniform operation and a better quality of iron will result.

How to Prepare Fast Burning Coke.

Granting that the most desirable property for blast furnace coke is rapid combustibility, it is very important to learn how this quality can best be obtained. Reference has been made to the manufacture of charcoal and its superior quality as a blast furnace fuel. Charcoal is a product of carbonization at a relatively low temperature. If charcoal is heated to higher temperatures, its ignition temperature rises and its combustibility decreases. The same is true of coke. The higher the temperature at which coke is produced, the less combustible it becomes.

Combustibility Dependent on Temperature of Production.

Charcoal retains the structure of the wood, while in coking coal a liquefaction occurs—the coal passing through a pasty stage before forming coke. This occurs at temperatures up to 930 deg. F. With further heating, the volatile components are expelled. In heating between 1380 deg. F. and 1470 deg. F. a very rapid evolution of hydrogen occurs and this hydrogen evolution continues even up to 1380 deg. F. With increased removal of the gases due to the temperature and time of heating, the hydrogen content diminishes and the character of the coke is changed. The coke becomes more and more slow burning and therefore less useful for the blast furnace.

The combustibility requisite for good blast furnace operation must be obtained by pushing the coke at not too high a temperature. The most suitable temperature lies between 1380 and 1520 deg. F. for good coking coals. Under some circumstances, it may even be as high as 1560 deg. F. It is by no means an easy problem to conduct the carbonization process in such a way as to observe this requirement. Stated in terms of usual American practice, the problem is to bring the contents of a by-product coke oven—10 to 12 ft. high, 35 to 40 ft. long, and of 14 to 18 in. average width—to the same temperature at the same time so that no part will be overheated and no part underheated. The problem is further complicated by the fact that the oven is 2 in. wider at the discharge end than it is at the pusher end. Moreover, the produc-

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*Stahl und Eisen, June 14, 1917.

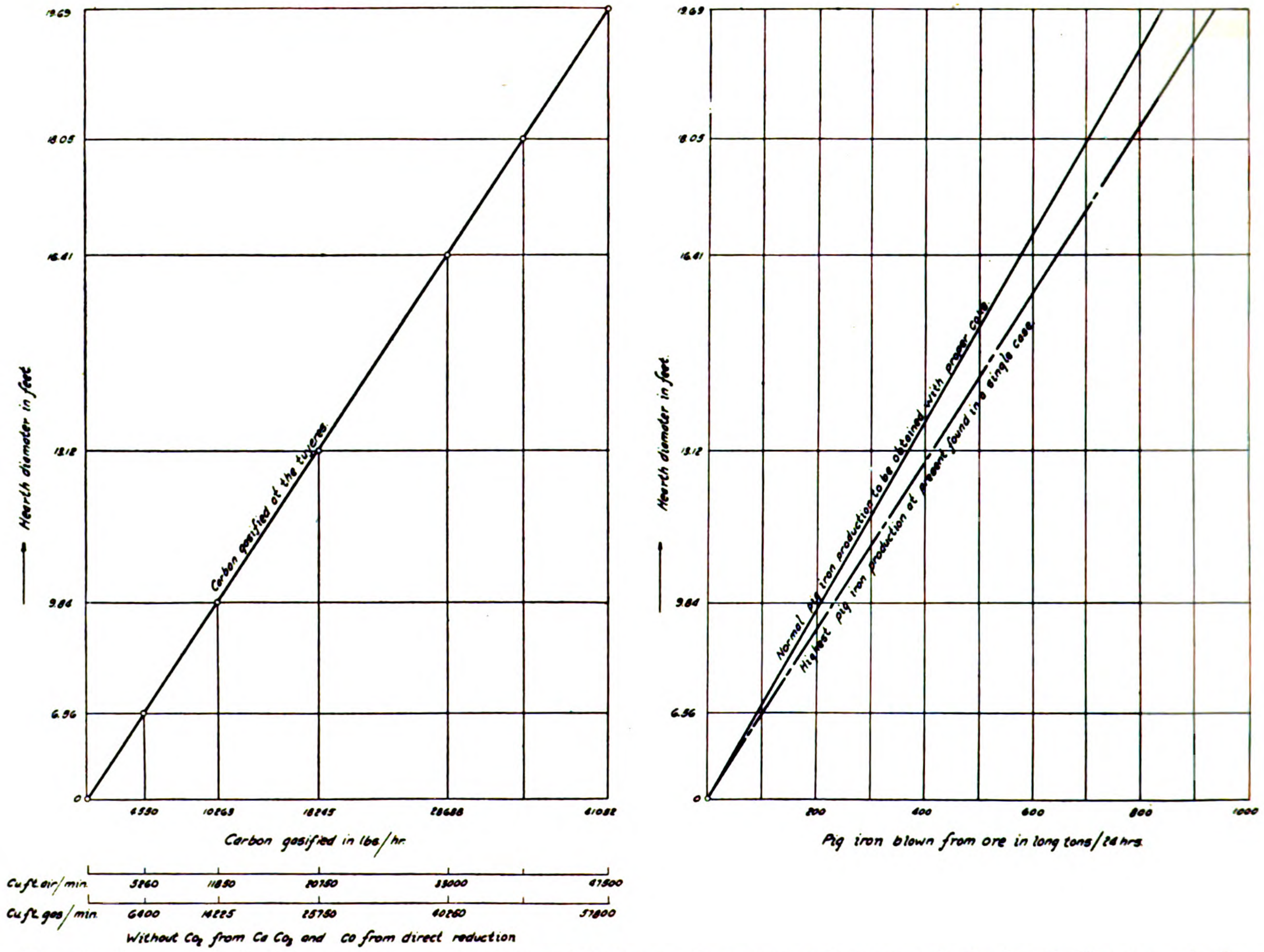

FIG. 11—*Increase in pig iron production and carbon gasification at the tuyeres with increase in the hearth diameter. At the tuyeres 135.1 lb. carbon gasify per sq. ft. and hr. 1 lb. C + 69.20 cu. ft. air = 84.26 cu. ft gas* (29.79 CO + 54.47 N_2). *With proper coke, 1000 lb. of pig iron are produced per* 527 *lb. carbon gasified before the tuyeres.* (*Furnace* 12 — *Howland*) *As a best figure there was found in a single case* 471 *lb. per* 1000 *lb. pig iron.*

tion of coke of the right quality should be affected in such a way as to recover the maximum quantity of by-products.

Developments in American Practice.

In order to obtain as nearly as possible the desired results, it is first necessary to begin with the coal. This must be properly prepared so that it is homogeneous and constant in quality. The coking should be preformed in relatively narrow ovens. The coke plant should be uniformly operated so that every oven charged can be coked in the same time and can be pushed exactly at a prescribed time. Koppers makes reference to a heat equalization process designed to correct the inequalities of heating that result whenever wet coals have to be used as in German practice, but does not give the details of this. In the discussion, much attention is given to American coking practice in which, according to Koppers, the superiority of coke pushed at relatively low temperatures was first recognized. In this connection, reference should be made to a paper* recently published by Joseph Becker, consulting engineer of the Koppers Company, describing the latest developments in American coking practice and showing how with an improved oven design it has been possible to obtain an extraordinary degree of uniformity in heating. In the new ovens, "the entire mass from top to bottom and from end to end was finished at the same time, the difference in temperature usually not exceeding

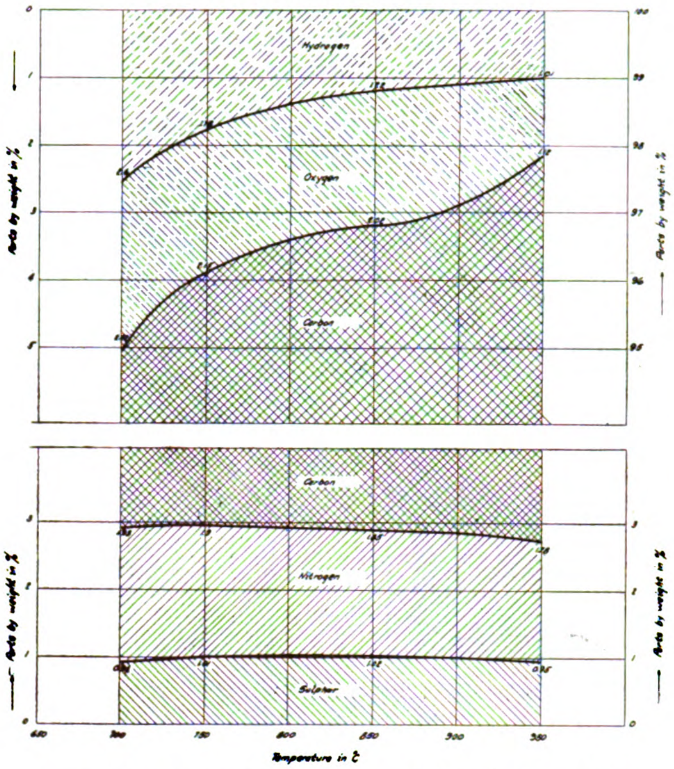

FIG. 12—*Composition of coke made in laboratory from Pittsburgh coal.*

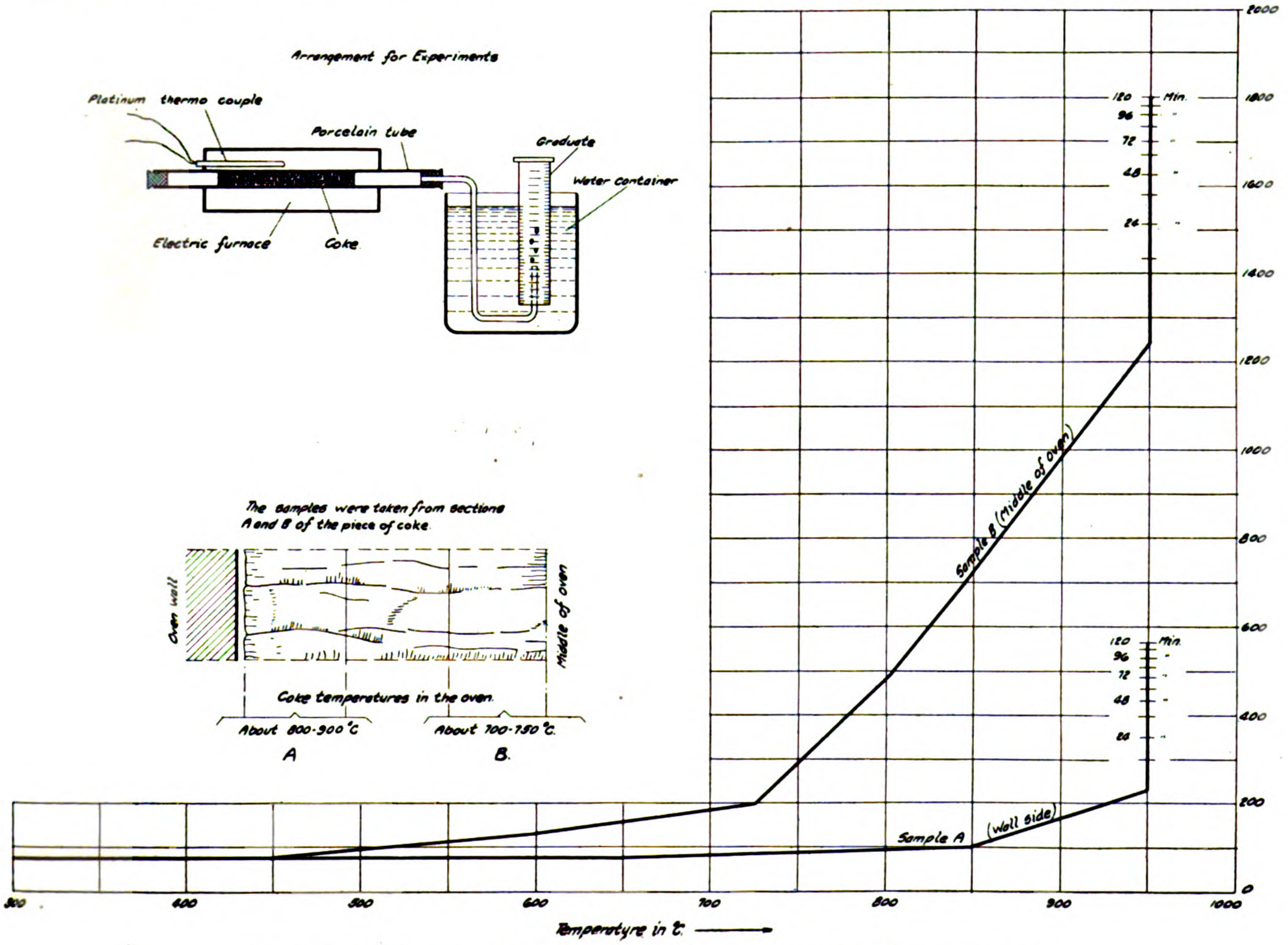

FIG. 13—*Experiments to demostrate the action of gases at various temperatures.*

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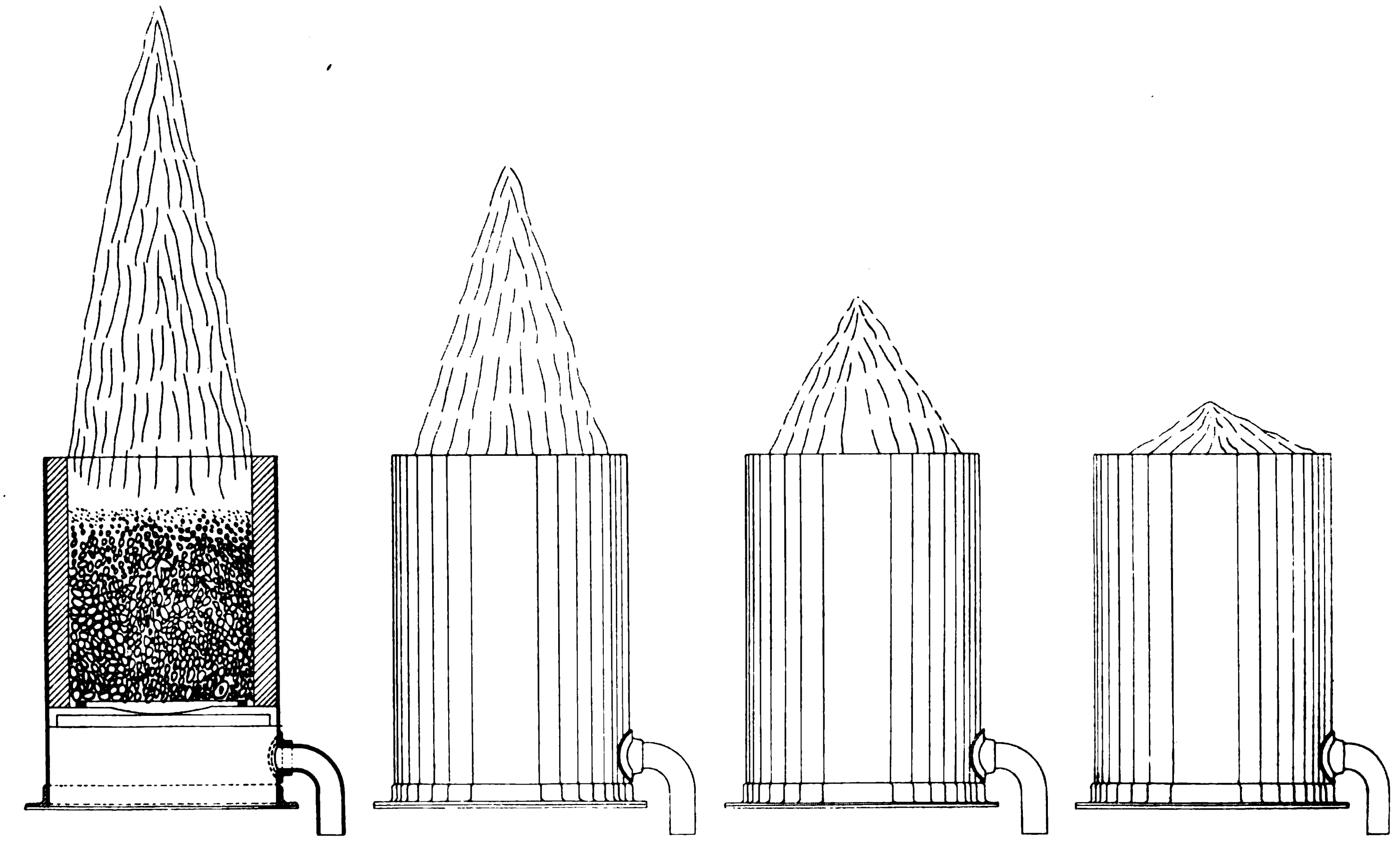
*Chem. and Met. Eng., November 1, 1922, p. 875.



Quick burning coke *Over-heated slow burning coke.*

FIG. 14—*Experiments made to show qualitative comparison of different coke combustibilities.*

100 deg. F." The coke produced in these new type ovens is, of course, very uniform in quality.

Investigations of Coke Quality.

In his paper published in Stahl und Eisen, April 13, 1922, p. 569, Koppers made extensive reference to the investigations of coke quality that have been conducted in the Mellon Institute Laboratories of the Koppers Company in America. These investigations, in recent years, have been mainly carried out by Mr. H. J. Rose, who has published some of his results in relation to the "Determination of the True Specific Gravity of Coke"†; but the greater part remain unpublished‡. It is planned to follow this review with a series of articles describing some of the more important work that has been done on the properties of coke. The partial description of this work that is given by Koppers is of considerable interest and will be presented herewith. Fig. 12 shows the composition of coke made in the laboratory from Pittsburgh coal at various temperatures, the constituents being calculated to an ash free basis. With the temperature range of 700 to 950 deg. C. (1292 to 1742 deg. F.) the hydrogen content drops from 2.6 per cent to 1.01 per cent and the oxygen from 2.52 per cent to 1.12 per cent.

Behavior on Heating.

A sample of coke was heated in an electric furnace gradually and uniformly to 950 deg. C. in such a way that the rate of temperature increase was 10 deg. per minute. The evolved gas was caught in a calibrated glass vessel. It was observed that lively gas evolution occurs at a definite temperature, corresponding in a general way with the temperature at which the coke was originally made. The quantity of gas evolved is increased with further heating and longer periods of time. The experiments are illustrated in Fig. 13.

The coke substance is therefore decomposed with increasing temperature, losing weight through the escape of hydrogen, oxygen, and other constituents and shrinking and becoming denser and slower burning. The change in specific gravity of coke caused by heating is illustrated by the figures in Table II of Rose's paper above referred to, parts of which are reproduced herewith.

TABLE II.

Sample No.	Description	Temp. of Coking Deg. C.	True sp. gr. of Coke 200 Mesh
B	Laboratory coke made from 100 per cent Pittsburgh Seam, high volatile coal.	700 750 850 950	1.702 1.798 1.817 1.823
C	Same coke as B, except that when made the heating was continued for 2 hrs. longer.	700 750 850 950	1.723 1.800 1.863 1.886

Specific Gravity and Porosity.

For a given coke, the determination of the true specific gravity may be used as an indication of its combustibility; but as Rose has shown, the correct determination of the true specific gravity of coke is a difficult matter and needs careful standardization. Furthermore, different cokes will differ greatly in this respect. It is probable that the general idea of determining the temperature at which vigorous gas evolution occurs will be the most useful and work along these lines had indicated that we may in this way be able to determine exactly the conditions under which the coke was originally made.

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†Jr. Ind. and Eng. Chem., Vol. 14, November, 1922, p. 1047.

‡For earlier work, see Jour. Frank. Inst., Apr. 1917, p. 391 and Aug. 1918, p. 133.

It is probable that an investigation of coke porosity should be of some value in connection with its combustibility. The rate of burning of coke would be expected to rise with increasing porosity on account of the increased surface exposed.

Direct Determination of Combustibility.

The question is naturally raised why we do not undertake to make a direct determination of the combustibility of the coke. Investigations of this sort have been extensively carried on by the Koppers Company at its Chicago plant and have afforded some interesting and valuable comparisons. It is Koppers' opinion that the direct determination of combustibility has so many elements that are so difficult to control that the indirect methods of investigation are to be preferred. He gives a qualitative comparison of the results shown by burning cokes of different combustibility in small cylindrical furnaces open at the top, admitting air at the same rate to the bottom of each. These experiments are illustrated in Fig. 14.

Summary.

The most important features of Koppers' work are summed up in the emphasized proposition that progress in the improvement of blast furnace operation must be made by securing better standards of coke quality than those of today. Present specifications for blast furnace coke refer almost solely to ash and sulhur content with some vague attention to size and strength. The highly important quality of combustibility is utterly disregarded. Koppers' proposals relating to coke, are recapitulated as follows:

1. Coke producers should select suitable coal of uniform quality and with low ash and sulphur and should coke this in such a way that the coke does not attain a temperature higher than 1200 deg. F. to 1470 deg. F. depending upon the kind of coal used.

2. Blast furnace men should use coke in pieces not larger than 4¾ in. and screened over a 1-3/16 in. screen (lumpy ore should be broken down to 2⅜ in. and less). The coke should not contain more than 8 to 10 per cent ash and should have less than 1 per cent sulphur and three per cent moisture. It should not readily be broken up into small pieces. **When heated to between 1290 deg. F. to 1380 deg. F. it should show a lively evolution of gas.** This last requirement is based on our Mellon Institute investigation, and may have to be modified or amplified as additional information is obtained.

In this connection, it should be noted that the requirements for foundry coke are exactly opposite to those for blast furnace coke. In the cupola, the coke serves only to melt the iron and, therefore, the greatest possible heat evolution is to be sought. It is of primary importance that the coke should burn before the tuyeres in the cupola to carbon dioxide and the conversion to carbon monoxide should not take place. Every pound of carbon burned to carbon dioxide produces 10,210 Btu. more than if it were only converted to carbon monoxide. The cupola gases should, therefore, contain as little as possible (not more than 3 to 5 per cent) carbon monoxide, since every per cent of carbon monoxide represents a considerable loss of heat. Foundry coke should, therefore, be slow burning and may well be produced by overheating.

ASSEMBLING A METALLURGICAL LABORATORY

(Continued from page 423)

Starch, C. P. powd. wheat	1	"
Sulphur, C. P. powd.	½	"
Sulphuric Acid, C. P. 1.84	90	"
Sulphorus Acid, C. P.	1	"
Tartaric Acid, C. P. cryst.	1	"
Tin, mossy, pure, gran.	1	"
Uranium Nitrate, Na free, cryst, C. P.	1	oz.
Vaseline	½	lbs.
Xylol, C. P.	1	"
Zinc, C. P. 30 mesh	1	"
" C. P. 30 mesh, amal.	½	"
" Oxide, U. S. P.	½	"
" Sulphate, C. P.	½	"
" Chloride, C. P.	½	"

Bureau of Standard standard samples.
Benzoic Acid
Oxalic Acid
Standard steels and irons.

United States Civil Service Examination

The United States Civil Service Commission announces the following open competitive examination:

Radio engineer, $4,000 to $5,000 a year.
Associate radio engineer, $3,000 to $4,000 a year.
Assistant radio engineer, $2,000 to $3,000 a year.

Applications will be rated as received until October 30. The examinations are to fill vacancies in the positions named, or in positions requiring similar qualifications, in the Federal classified service throughout the United States.

The duties are to conduct or superintend the development, design, construction, installation, standardization, and the writings of specifications for practical and special apparatus and methods of radio communication, such apparatus to include sets for land use for more or less permanent stations, also for portable land stations, and for airplanes and ship sets, and similar lines of work.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects Education and preliminary experience, 30 per cent; special experience and fitness, 40 per cent; publications, reports, or thesis, to be filed with application, 30 per cent.

More Belgian Blast Furnaces Working

Belgian blast furnaces operating on July 1 totaled 38 (compared with 35 on June 1), producing 7,250 metric tons of basic pig and 225 tons of foundry iron per 24 hours, according to a report to the Department of Commerce from Commercial Attache S. H. Cross. The present base price of blast furnace coke has increased 10 francs to 211 francs per ton. Despite increased demand, rising production holds pig iron prices steady, foundry No. 3 being quoted at 460 francs and basic at 425 francs. Heavy sales during the past month, especially in England, have raised semi-finished steels about 65 francs per ton. Quotations on Bessemer products are now as follows: Blooms, 565 francs; billets, 615 francs; sheet bars, 630 francs.

All finished steels have advanced 50 to 75 francs per ton since the middle of June, bars now being 700 francs; structural shapes, 700 francs; and rods, 825 francs. Local business is favored by the absence of competition from Luxemburg, which is laboring under difficulties of fuel shortage. The sheet and plate market is improved, prices having increased about 50 francs in the last four weeks. Bessemer sheets 5 mm. thick are now 725 francs per ton, sheets 1 mm. thick are 1,050 francs, and galvanied sheets 1 mm. thick are 1,800 francs.

THE SAFETY CRUSADE

Salvaging Skulls With Oxygen

Two Men in a Few Hours Do the Work Which by Old Methods Took Five Men Several Days of Dangerous Work.

NEARLY every steel plant or blast furnace has tons of valuable metal in the form of skulls, spills and sometimes even small salamanders; often the accumulation of years, which are worthless unless they can be remelted. These are generally too heavy and bulky to break in the regular way with the drop-ball. They can, however, be economically salvaged by the oxygen cutting process.

Occasionally the problem of reducing these masses of metal to charging-box size is solved by drilling holes with an electric or compressed air drill and blasting. This method, while it serves the purpose in a fairly satisfactory manner, is not a practicable one from a cost standpoint, since the value of the time and labor necessary to reduce a skull to the proper size in this way often exceeds the value of the metal reclaimed. So thousands of tons of skull scrap metal are still on the scrap piles occupying in many cases very valuable ground space which makes them a source of expense rather than a realizable asset.

Reducing the hazards of breaking skulls. Burning with oxy-acetene.

The use of the oxygen lance in the opening of frozen tap-holes, and in drilling large salamanders when it is necessary to remove them in the shortest time possible is a well known application which is used extensively in every iron and steel producing center. Among the plants which have recently found it advantageous to go a step further than this is a southern steel plant where the oxygen lance is now used for drilling holes for blasting to reduce skull scrap to charging-box size.

The method of doing this work is to heat a spot on the skull to a bright red with an oxy-acetylene welding blowpipe, or to place a cube of steel heated to this temperature on the skull. Oxygen under comparatively high pressure is then directed aganist the heated spot or the red-hot cube of steel through an iron or steel pipe of suitable diameter. (Usually ¼ in.) The oxygen actually burns or cuts the metal of the skull, and the pressure of the oxygen blows away the resulting slag as it is formed, thus drilling the hole. During the process the pipe through which the oxygen passes is gradually consumed; the heat generated by the combustion of the pipe aiding in drilling the hole.

The burning of the pipe aids especially when slag pockets or sand holes are encountered. Sometimes, however, these are of such size that the drilling is temporarily interrupted. In this case a red-hot rivet shank or similar piece of metal is dropped into the partly drilled hole, and when the oxygen jet is directed against this, the added fuel furnished by the metal introduced generally carries the hole through the obstruction.

An interesting variation from the usual straight lance, fed down vertically through a tripod, is used in the southern plant mentioned. The lance is made of two sections of pipe, coupled together at right angles, as shown in the accompanying photograph. A lance of this type permits the operator to take a position far enough from the hole being drilled to properly observe the work, unhampered by the smoke and sparks.

The oxygen is furnished from cylinders connected up with a manifold, and a high-pressure hose is used on the oxygen line from the regulator to the lance. The use of the manifold assures a sufficient volume of oxygen for the work and prevents freezing in the cylinder valve or regulator from an attempt to pass large volumes of oxygen through the small passages too rapidly.

Drilling skull scrap in this way, two men can do in a few hours the work which will require by the old methods the services of five or six men for several days. This reduction in labor cost in the case mentioned made possible the profitable reclamation of metal from the scrap pile which otherwise might never have been salvaged.

Co-operation in Accident Reporting

There have been a number of cases, both in the mines, furnaces and mills, where men have claimed that they were injured on the job and where the boss, timekeeper or safety engineer, and even the man's partner, did not know of the injury.

This is one of the meanest cases to handle that could possibly happen. We have been able to prove in a number of such cases that the man claiming injury was indulging in plain, ordinary lying, while in others we have found that the injured man was telling the truth, but in all of these cases there was a great deal more trouble caused to all concerned, and particularly to the injured man, than would have been the case had he reported the accident immediately after it happened.

Let every man realize that he is not only helping the timekeeper and safety engineer, but is also helping himself when he reports an injury, no matter how slight, and has a record made of the accident. Put yourself in the safety engineer's place. If you were holding his job and a man would make application for compensation a couple of weeks or a month after he claimed the accident happened, and no person about the mill, not even the man's partner, could remember about the man being injured, wouldn't you be inclined to doubt whether the man was injured on the job at all, and wouldn't you do all you could to avoid being charged with a serious accident?

It seems strange that we are required to say anything about this matter again, but recently we have had a number of cases of infection, one of which stands out prominently as a warning to all men. This particular man received a very slight abrasion of the skin on one finger. He did not even mention it to his partner until five days after it happened. He claims he struck the finger against a part of his machine. We don't know. Maybe he got it at home cutting kindling, or somewhere else, but he is now, and has been for several weeks, at death's door, and the doctors are doing all they can to save his life. At any rate, we do not feel like charging a serious accident to the plant in which the man worked, when we do not feel at all sure that he was hurt in that plant. How much simpler it would all have been had the man reported the accident the day it happened and had a little first-aid dressing. There is a 100 to 1 chance that he would then not have lost a shift from his work.

But even, if he had lost a turn or two, he would at least have learned the lesson of obeying company rules laid down, not by guess work and for the company's selfish advantage, but by experiences gained through thousands of cases, and in most cases designed entirely for the individual's own best interests.

Let's get together on this propositon. The safety engineers, first-aid men and timekeepers are hired and paid by the company to take care of you, and if you give them a square deal they will treat you with the utmost courtesy and fairness. But if you do not report your injuries at once, you cannot but expect to encounter difficulties if it turns out more serious than you expected.—*The Anode.*

Do You Get What You Pay For?

By WILLIAM R. BASSET*

When you buy materials, you specify carefully the quality you require, and you pay the bill only after an inspection has shown that you received what you bought, both as to quantity and quality.

But when you buy labor do you pay for the right quantity and quality, or do you buy a pig in a poke? If you pay a workman only for being present in your plant between the hours of 8 and 5, you are buying something "sight unseen," and probably with the usual results.

Payment for production, in some form, has been applied somewhere to practically every job that a man can be called on to do. It may be piece work, premium and bonus or any one of a dozen plans.

Even where unions have ruled rigidly against any form of payment except day work, I have seen men willingly increase their production for the sake of extra earnings. There is just one attribute that you can bank on every worker possessing—he wants more money, and most of them will work to get it.

Payment for production applies not only to those workers commonly classed as productive. I have seen methods worked out for janitors, truckers, stockmen, millwrights and others of the so-called non-productive kind.

But there is a right and a wrong way to use wage incentives. A poorly designed wage incentive may hold back instead of stimulate production. And it is important to "sell" the men on the plan. If the method is correct and if it is explained to the men clearly, they will nine times in ten give it a fair try. It pays to have the method worked out and the standards set by men of experience and skill. An amateur or a bungler can cause tremendous trouble.

It is not at all uncommon for production to be doubled, by a good incentive. I have seen costs reduced 75 per cent while the workers' earnings were increased 30 per cent.

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*President, Miller, Franklin, Basset & Co., Inc.

Amalgam Fuel Possibilities in the Orient

The Limitation of Suitable Coking Coal Reserves, and the Possibilities of Future Oil Developments Demand a Very Careful Utilization of Existing Resources.

By J. V. McCARTNEY*

FUELS made by amalgamating the finely divided carbonacious content of coal with low grade fuel oils have lately received considerable attention in this country in view of the possibility of utilizing screenings, slacks, high ash coals, etc,. in the production of these amalgams.

A feature of this development is the efficiency with which both anthracite and bituminous coals of moderately low ash content and low-grade fuels having a very high ash content such as lignite may be treated. In each case satisfactory amalgams of coal and oil can be produced and these can be burned as liquid fuels by means of special burners or directly by use of stokers.

A further peculiar and very important characteristic of amalgam fuel is its tendency to coke and this applies quite as well to amalgams made from non-coking coals as to those made from coals having well-recognized coking qualities. Also, as the iron pyrite, and soluble sulphur salts are largely removed in the amalgamation of the coal and oil, coke made from amalgam is quite free from sulphur and particularly well adapted to metallurgical uses.

That low-grade coals can be utilized in producing amalgams which have all of the essential qualities of high grade coal, and that from these amalgams a good metallurgical coke can be produced, makes this development particularly applicable to the industrial expansion now taking place in India and China, due to the fact that in both of these countries the known and probable coal reserves are not only of quite limited extent but that the amount of low-grade coals is greatly in excess of coals of good quality.

About 98 per cent of the coal supply of India is obtained from the Gondwana measures, while all of the known coal deposits of importance, (and the country has been quite thoroughly prospected in recent years), are in the area between the Ganges River on the north and the Godavari River on the south. The largest deposits of high grade coal are confined to a much smaller area in northern Bihar and Orissa and comprise three well-known fields, the Ranigunj field containing some 20,000 million tons of coal of all grades mostly inferior and unsuited for making blast furnace coke, 500 million tons, however, are of first quality; the Jherria field, with about the same amount of first quality coal and the Karanpura field further west containing some 600 million tons of good coking coal. Including the smaller fields there is a total estimated reserve of some 80,000 million tons.

All of the Indian coals are high in ash, the best Bengal coal usually containing about 12 per cent. The following analysis of the coals from the more important fields indicates the variation in quality:

	Moisture	Volatile Matter	Fixed Carbon	Ash
Ranigunj	3.75-7.00	31.-32.	46.-49.	11.-15.
Jherria	1.0	29.	59.	15.
Barakar	1.0	25.-26.	52.-60.	14.-19.5

China's natural resources, until recently, have been

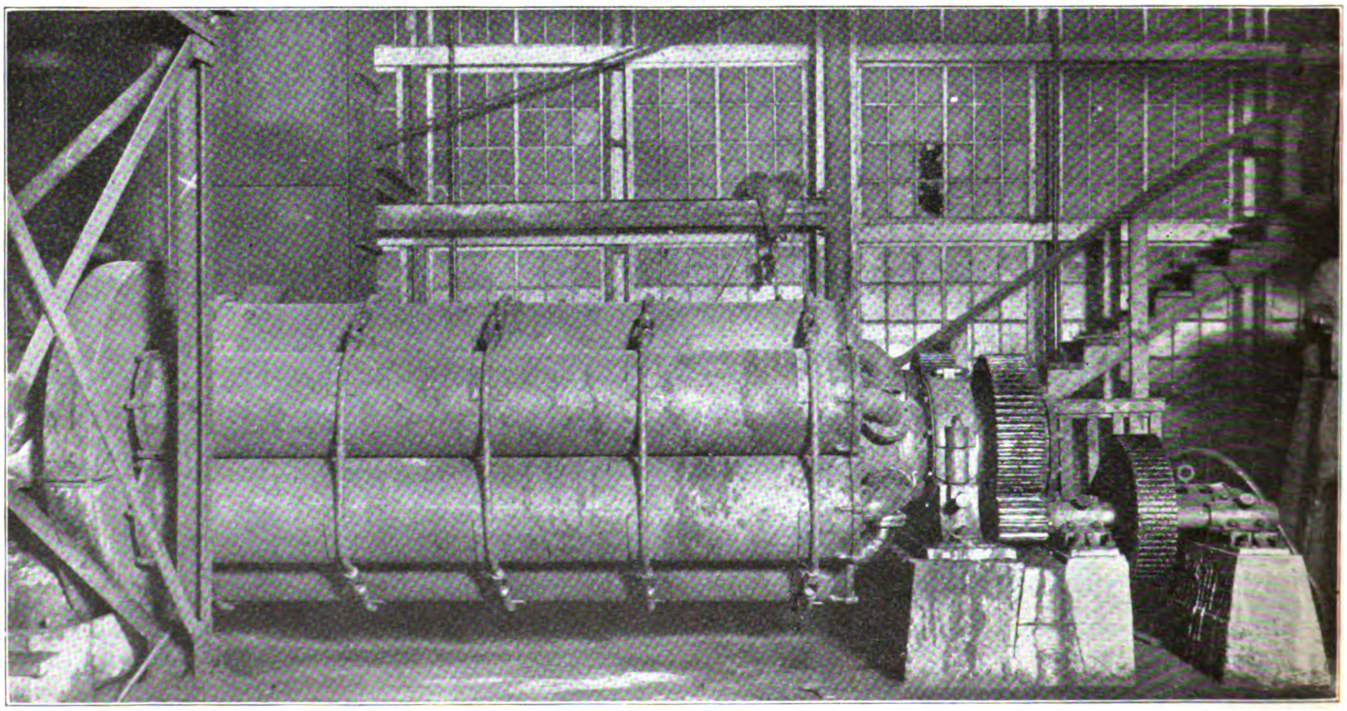

FIG. 1—*Huge bar type, slow-speed pulverizer used in the Trent Amalgam process.*

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*Consulting Engineer, Chicago, Ill.

greatly exaggerated; from the most reliable sources her coal reserves are estimated to contain about 40,000 million tons or one-half of those of India.

The provinces of Chihli, Mukden and Shansi in the north and Kiangsi in the south are the only areas capable of supplying coal suitable for metallurgical purposes in large quantities.

Anthracite is found chiefly in Hunan, which has an estimated reserve of 1,600 million tons and Honan with a reserve of about the same amount. In Kiangsu, Anhui and Chekiang the coal is usually of a poor quality; this applies also to Manchuria which has recently been developed by the Japanese in connection with the new iron and steel industry. The bituminous fields of Yunnan, Kweichow, Szechuan, Kansu and Shensi contain fairly large reserves of low grade fuels that will be available as soon as railroads are extended into this territory.

Chinese coals are all quite high in ash as is characteristic of most of the Asiatic coals. On the average the ash content varies from 10 to 12 per cent to 24 per cent or higher. This variation is indicated in the following analysis of the coals from the more important fields:

	Water	Volatile Matter	Fixed Carbon	Ash	Sulphur
Manchuria—Pen-hsi-hu Area:	.1-.2	16.-21.	50.-72.	9.-31.	.7-2.0
Honan	.8	6.-14.	75.-85.	9.-10.	.6
Shansi	.5-4.5	3.5-30.	65.-84.	4.-23.	.5-2.8

As an adequate supply of fuel oil is necessary for the successful production of amalgam fuels on a commercial basis, it will be well to mention here the available sources of such oil for use in the countries under consideration.

Petroleum is found in India in two distinct areas, one on the east which includes Assam, Burma and the islands off the Arakan Coast. This belt extends to the productive fields of Sumatra, Java and Borneo. The other area is on the west and includes the Punjab and Baluchistan, the same belt, of oil-bearing rocks being continued beyond the borders of British India to Persia. Of these two, the eastern area is by far the most important; the most successful fields being found in the Irawadi valley; Yennang-Yaung is the oldest and most developed while Singu holds the second place among the oil fields of India.

In 1920, the Burma fields produced 1,865 million gallons; Assum 13 million gallons and the Punjab only 51,500 gallons in all, which shows rather strinkingly the comparative values of these two oil-bearing areas.

Unlike India, China has no well developed oil fields. The known oil occurences are very few, the so-called Red Basin of the western provinces being one of those that gives even a little promise as a possible large source of petroleum. Although small quantities of oil have been obtained for centuries in Shensi province, the geological formation would indicate that there is not much possibility that this area will ever produce on a large scale. In Szechuen province, the most important oil bearing district lies in the east-central part about 100 miles west of Shungking. There are about 50 wells in operation, the majority being in the Tze-lin-ching district, which produces about 30,000 barrels annually.

It would appear from the most reliable information available that the only area that may be expected to produce oil in really paying quantities lies in the extreme western part of the country and as this area will not, in all probability, have railway facilities for a considerable period, China's industrial development must depend upon outside sources for its oil supply. Fortunately, there are several such sources within comparatively short distances of her ports. The most important of these is the Dutch East Indies which produced in 1920 some 48,000 barrels of oil daily. Aside from these producing areas, in Sumatra, Java and Borneo there are indications of petroleum in commercial quantities in the Celibes and Ceram islands and also in the Philippines which lie in the oil producing belt extending from the East Indies to Japan, where 5,800 barrels were produced daily in 1920.

Compared to western industrial countries, the coal reserves of India and China, so necessary for the development of modern industries, are relatively small. The estimated coal reserves of this country amount to 3,500,000 million tons; of England, 125,000 million tons; of Germany, 56,000 million tons, as against 80,000 million tons for India and 40,000 million tons for China.

Second only to coal in the industrial development of a country is the importance of its iron ore resources. In this case, India is particularly fortunate with an estimated reserve of 20,000 million tons of high grade ore, while this country is a poor second with 4,700 million tons; then follows Germany with 3,000 million tons; England with 1,250 million tons and China last with 1,000 million tons.

With these comparisons in mind, the present consumption of fuel in India and China and the probable demand upon the coal reserves of these countries by the expanding industries will be indicated.

The per capita consumption of coal is probably much lower in India than in any other important country in the world. However, as an indication of the industrial development, this is in itself, misleading for since 1917 the demand for fuel increased very rapidly and in spite of increased imports, it was found necessary to place an embargo on exports, the domestic supply being entirely insufficient to meet the increasing demands of the country, due to the rapidly expanding industries.

In the year 1921 the total tonnage of coal mined in India was 18,359,000 tons of which the mines of Bihar and Orissa produced 12,965,000 tons and those of Bengal 4,260,000 tons. It is estimated that the output for the above provinces could be increased to about 24,000,000 tons a year if the labor would work more steadily. In view of this condition and also because the railways are inadequately equipped for handling yearly tonnages much in excess of the 1921 figure, the importation of coal increased to 1,489,000 tons for the year mentioned.

The chief users of coal in India are the railways, the shipping industry, iron and brass industries, cotton and jute mills and brick and tile factories. In 1921 the railways used 6,200,000 tons of coal; the shipping industry for bunkering purposes about 2,000,000 tons; the iron and brass foundries, 1,500,000 tons; jute mills, 1,100,000 tons; cotton mills, 1,100,000 tons and brick and tile factories about 500,000 tons—giving a total coal consumption, including that used by smaller industries, of 16,900,000 tons for the year. This figure excludes the wastage at the mines, the small consumption in dwellings and that used by unenumerated industries.

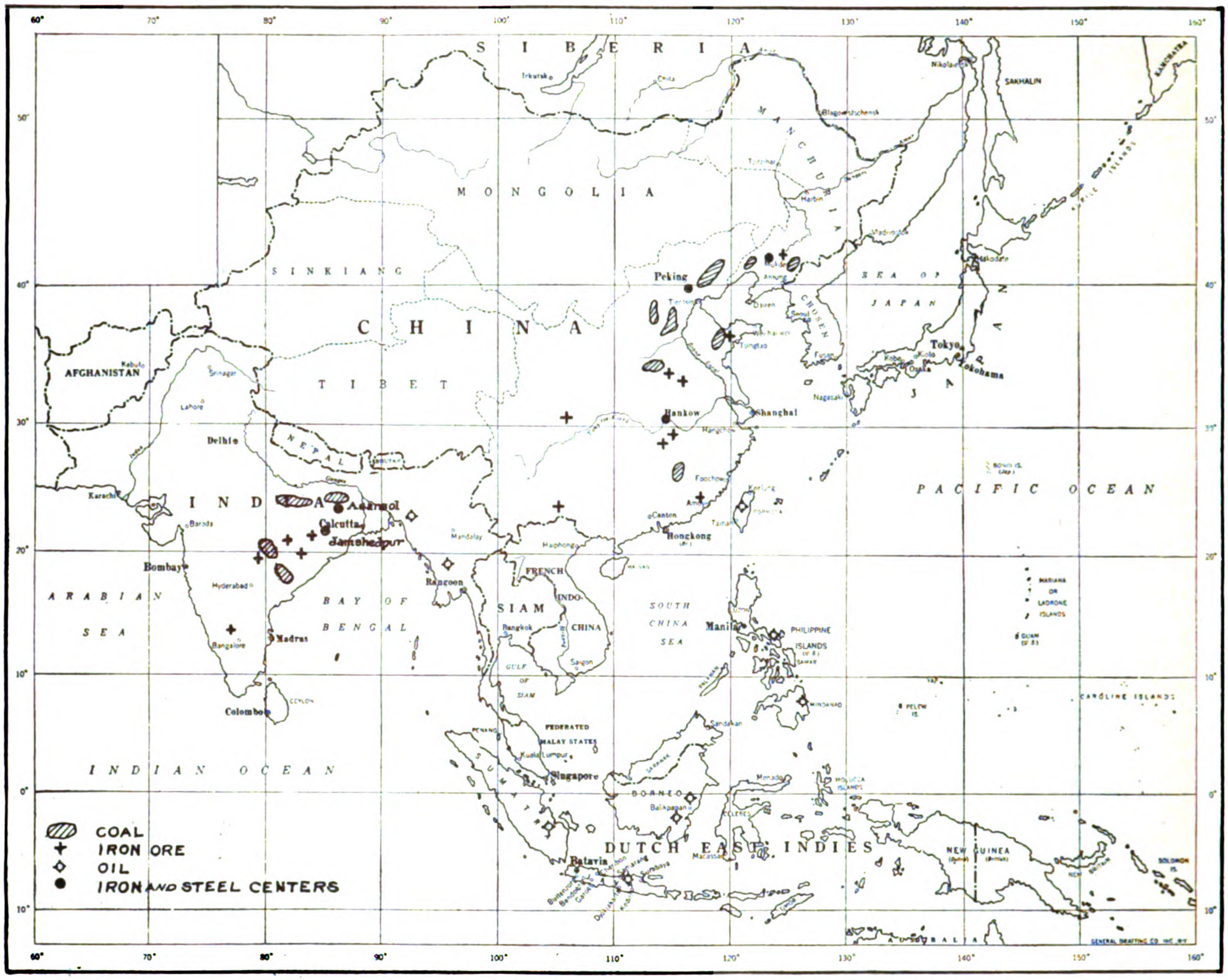

FIG. 2—*Map, showing iron and coal deposits of India and China, reference to which indicates India's favorable position both for smelting operations and finished products shipment.*

As to the probable expansion of those industries using large tonnages of coal, it is interesting to note that in 1920 India had 36,750 miles of railway of all gauges, or an increase of 2,000 miles over the mileage for 1914. This represents rapid progress considering the complications introduced during the war period, and although the Government is insisting upon material changes that will greatly improve the situation and have authorized the expenditure of $475,000,000.00 during the next five years, it is improbable that the railway development will be able to keep pace with the growing demands of 315,000,000 people who have definitely decided upon industrialization.

The industrial development of the country depends almost entirely upon the expansion of the iron and steel industry; so much so that this expansion may be considered as the pulse of the whole situation.

As noted previously, conservative estimates place the high grade ore reserves of India at 20,000 million tons, all located within an average of 150 miles of the principal coal fields and largely within the confines of Bihar and Orissa. A very large part of this ore analyzes from 60 to 65 per cent metallic iron and in certain areas the iron content runs as high as 67 per cent, while on the average, the percentage of phosphorus is about .10 and quite uniform.

At present there are three companies operating in this area, the Bengal Iron Company at Kulti, near Asansol; the Indian Iron and Steel Company at Burnpore, also near Asansol, and the Tata Iron and Steel Company at Jamshedpur, the two first named being about 145 miles northwest of Calcutta and the third about 155 miles due west of this Indian metropolis. The Bengal Iron Company is the oldest, having been started in 1875 as the Barakar Iron Works and has in operation four 80-ton blast furnaces; the next to enter the field was the Tata Iron and Seel Company which started operations in 1912 with two 200-ton blast furnaces (since enlarged to 350 tons daily capacity each) and the necessary open hearth furnaces and mills to convert this tonnage into steel shapes. This Company has since added one 300-ton furnace and one 500-ton furnace and additional furnaces of the larger capacity are contemplated for the near future; following the success of the Tata Company the Indian Iron and Steel Company was formed and has recently completed the erection of two furnaces of 350 tons capacity.

Two other projects of considerable size are now under consideration, the United Steel Company of Asia, Ltd., and a second development in which Messers Villiers and Company are interested. Both of these interests have secured control of large deposits of high grade ore within a few hours' ride of Calcutta and propose to erect extensive plants in the near future.

The growth of the industry as above outlined will extend over a period of years till 1926, at which time an investment of 44.5 croves of rupees ($142,000,000) will have been made and 125,000 males, with an annual payroll of 6 croves of rupees ($19,200,000) or nearly three times the present force will be required.

India is expected to show a very rapid development in the direction of machinery production covering such lines as machine tools, textile machinery, mining machinery, low-speed engines, hydraulic presses, pumps, road building machinery and many others. All of these lines were successfully produced during the stress of the war period and considering that India absorbs each year $102,000,000 worth of machinery of all types, it is apparent that this development will have considerable bearing upon the growth of the iron and steel industry.

A further tributary development of the iron and steel industry that is expected to show rapid growth are plants for production of such articles as steel and brass tubes, plates, wire, copper and brass rods, bolts, screws, drills, cutters, springs and other products required in large quantities by modern factories. A number of companies, independent organizations and subsidiaries of the steel companies, have been formed to meet this demand and others are contemplated.

China appears to mine and consume about 23,000,000 tons of coal yearly. About half of this amount is used for domestic purposes whereas in India due to the warm climate the domestic consumption of coal is practically insignificant. The amount consumed in the industries, including the shipping industry, is perhaps about 9,000,000 tons per year, while the annual consumption of the railways is not far from 1,000,000 tons. This indicates a total of 10,000,000 tons as the yearly requirements of the Chinese industries and gives a measure of the present industrial development of the country.

The railways of China total less than 7,000 miles as compared to more than 36,000 miles in India. Certain extensions of existing lines are projected and a number of proposed lines that will open up new territory are being considered, but little development can be expected while the present chaotic conditions into which the government has fallen, exist. Once the development of the country is well under way, however, it will be very difficult for the railways to keep pace with the demands of the immense population and as the oil resources of the country are apparently negligible, coal will be the only fuel available for operating purposes.

Among the more important industries using large amounts of fuel annually are the shipping industry, the textile industry, power plants and the iron and steel industry.

For various reasons, the latter industry has not been very successful to date and it is not expected that iron and steel products from Chinese furnaces will be able to compete favorably, for some time, in the Eastern markets.

The plants of this new industry may be separated into three groups, occupying three distinct areas, the development in Manchuria, the development near Pekin, and those at Hankow.

The Aushan plant in Manchuria, developed by the Japanese, is experiencing operating difficulties due largely to the low grade ore which averages about 30 per cent metallic iron and which will require concentration before successful furnace operation is possible.

In the Chihli district, near Pekin, the new 250-ton blast furnace of the Lungyen Mining Administration, has just been completed and it is expected that this plant will indicate the possibility of producing iron, profitably, with a modern furnace operating under favorable conditions.

At Hankow are the plants of the Yangtse Engineering Works and the Hanyang Iron and Steel Works; the latter was founded in 1890 by the Viceroy of Hupeh Province and consists of six blast furnaces, a rail mill, plate mill and bar mills. Owing to the unfavorable location of the plant on the Yangtse River, all raw materials must be rehandled by coolie labor; this has proved to be very expensive and taken with other pecularily bad conditions, such as obsolete equipment and cramped mill space, has made the profitable operation of the plant impossible though the ore used is from the Tayeh mines and analyses 60 per cent metallic iron. The single 100-ton furnace of the Yangtse Engineering Works has not proved very successful largely because the company has no direct control over the source of raw materials used.

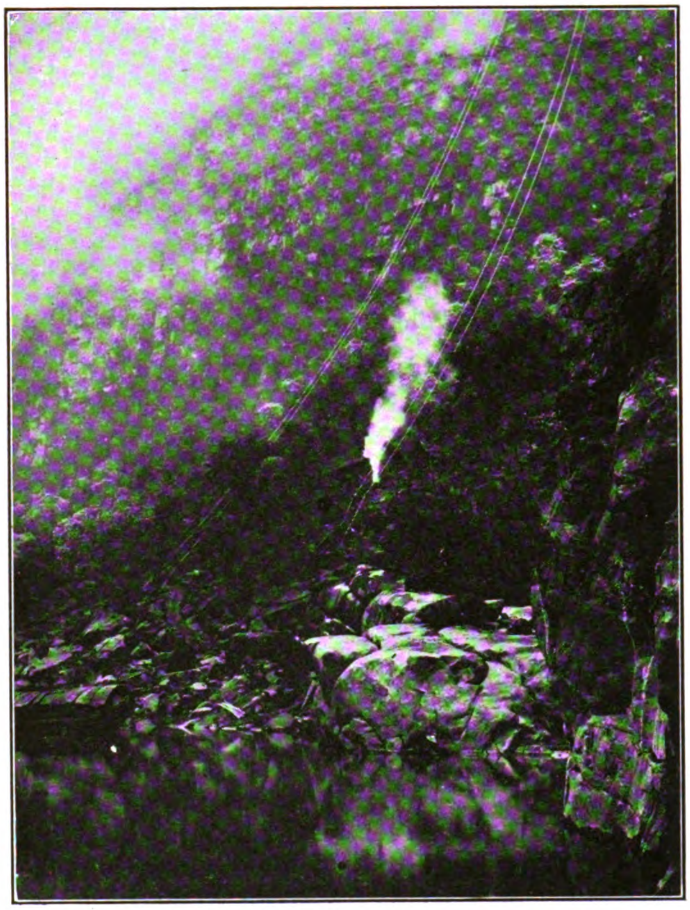

FIG. 3—*Coal mining on the Yantze River, in China. The coal is transported down bamboo cables, the seam being high up in in the hills. Courtesy "China Review."*

The iron and steel industry of China must necessarily await for development upon railway expansion, the installation of labor saving equipment for raw material handling and upon modernization or abandonment of the older furnaces and mills.

In providing China with modern industries, many difficult problems will be raised and although the industrial possibilities seem boundless, it must be understood that at present there is no co-ordinating force at work as there is in India or Japan.

In view of the relatively small coal reserves of India and China, there is urgent need that fuel of all grades be conserved. The consumption of coal in India during the last fiscal year amounted to approximately 100 per cent more than during the same period a decade ago and is a very striking indication of the growing demands that are being made upon her fuel reserves. A most important feature of this growth is the requirements of the iron and steel and allied industries. It is conservatively estimated that the quantity of good coking coal available for metallurgical uses is not more than 2,000 million tons and when it is realized that the future industrial development of the country depends upon these reserves, it is evident how necessary their convervation becomes. The ore deposits of Bikar and Orissa are among the largest and richest known, and if developed, will require corresponding amounts of blast furnace coke which, if available, will result in India ranking among the great iron and steel producing countries of the world. If the present rate of increase in coal production continues, the yearly output 15 years from now will be over 50,000,000 tons, which means, even if no future increase took place, the extraction of 2,000 million tons in 40 years. Unless India is to be faced, at no very distant date, with the loss of her metallurgical industries for want of coke, it is absolutely necessary that, in addition to conserving her resources, the lower grades of coal be made available for industrial uses. For this purpose the amalgam process is well adapted and is in fact the only method that has been successfully employed in cleaning high-ash coals such as those of India.

While China's coal reserves amounting to 40,000 million tons, are considerably less than those of any important Western country, yet if we look at the matter from the viewpoint of the countries on the Pacific, it is evident that China is the only one of such countries with respectable resources.

Australia has only 4,000 million tons, Japan about the same amount, and the Pacific Coast of America is no better off. Not only is the consumption of coal in China bound to increase, but also as such increase will be fairly rapid and prolonged, it is safe to predict that the Chinese coal industry will, before long, become the most important factor in the economic development of the Far East.

While the iron ore resources of China are only one-twentieth of those of India and her iron and steel development will make a correspondingly less demand upon her coal reserves, it must be remembered that these reserves are only one-half those of India and further that the present annual consumption of coal in China for domestic purposes is 10,000,000 tons as against an insignificant amount for such purposes in India.

From such considerations, it seems necessary that the coal reserves of China must be strictly conserved or the growth of her railways and the expansion of her industries which appear to have such great potential possibilities, will be seriously hampered. Here again, amalgam fuel is the logical development for use with the low-grade, high-ash coals common in China, although as compared to India, there is this difference; India has definitely launched upon an era of industrial expansion in which public and private interests have been co-ordinated by the Government, whereas, China has no such development and may be regarded as a country of wonderful possibilities that are potential rather than active.

Of the two countries, India offers a very large field for the present application of the amalgam process; China's requirements are largely in the future.

The Lifting Magnet[*]

Labor Shortages and Rising Production Costs Demand Practical Solutions.

On the average one strong man can do as much work handling iron or steel as can be done by $100 worth of lifting magnet. In other words, a $1,600 magnet can do the work of sixteen men and of course the magnet can do more if worked more hours per day.

The total cost of owning and upkeep and power for a magnet equals about 10 cents per day per $100 or $1.60 per day (1 per cent) for a $1,600 magnet. This total cost includes interest, depreciation, upkeep and cost of current.

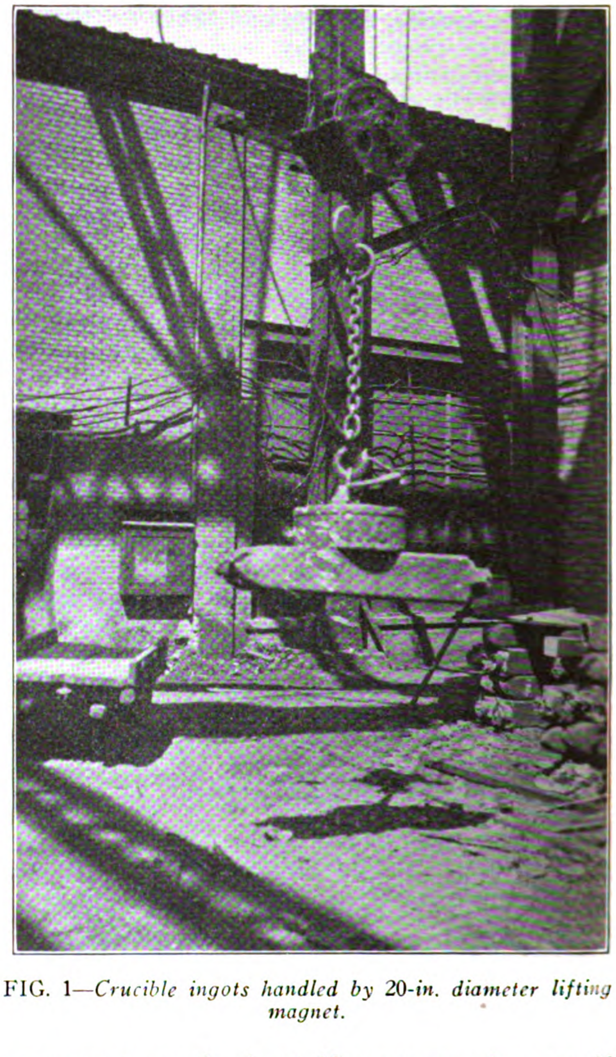

FIG. 1—*Crucible ingots handled by 20-in. diameter lifting magnet.*

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[*] Data and photographs supplied by Ohio Electric & Controller Company, Cleveland, Ohio.

Based on these two statements of fact it becomes easy to figure whether it will pay to use a lifting magnet for any given job and to demonstrate that this doesn't always mean great quantities of material, some instances are noted.

In one of our largest plants rivets are made and conveyed to a boot behind a long annealing furnace. Here a magnet 10 in. in diameter is automatically lowered and hoisted. When down it is energized and picks up 25 to 40 pounds of rivets and when it reaches the top of its travel it is de-energized and drops the rivets onto a chute and they thus enter and go through the annealing furnace a few at a time, just as was desired and save a man on each turn. No photograph is available.

Fig. 1 shows a magnet which weighs about 500 pounds handling two small ingots at the Sanderson plant of the Crucible Steel Company. This magnet not only reduced the amount of yard labor required but enabled them to pile their ingots closer and higher since no spaces need be left for chains.

Two magnets 20 in. diameter attached to a spreader beam, the magnets being spaced 8 ft. apart. These are used to handle all sizes of steel pipe, the small sizes being in bundles. The average lift is about 900 lbs. Sets like this are used in several pipe warehouses for unloading and reloading and general hauling. They reduce labor required and also the accident hazard.

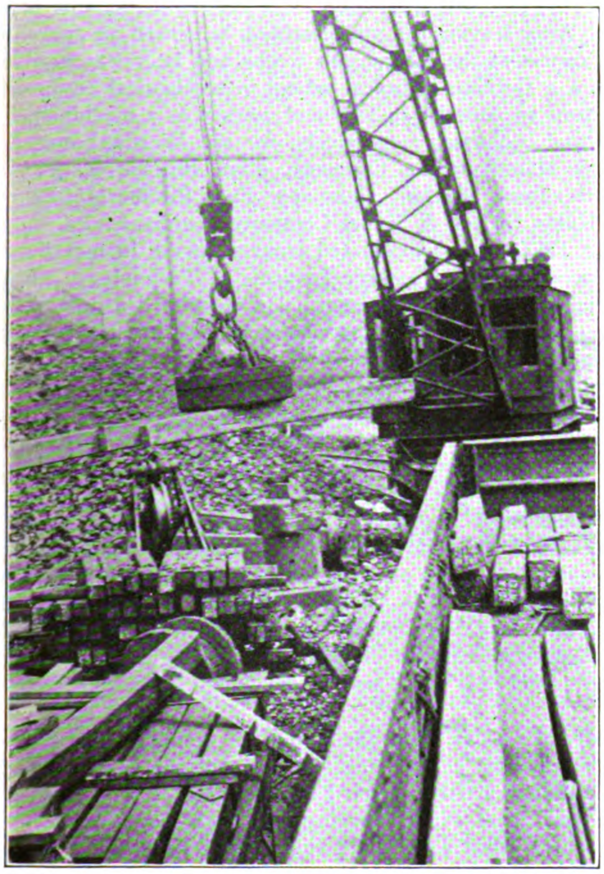


FIG. 3—*Magnet working in yards of Pittsburgh Steel Forge Co.*

Fig. 2 shows a 40-in. round magnet unloading three 2,000-lb., 8-in. x 8-in. billets but this is only an occasional job. The regular work of this magnet is to load one car of plate scrap per week and while this is not much work it saves about $35.00 per week or about the cost of the magnet per year and does a job otherwise hard to take care of and formerly the cause of considerable labor turnover.

Fig. 3 shows a 40-in. magnet (since duplicated) handling billets in the yard of the Pittsburgh Steel Forge Company, used to save labor cost and increase the capacity of the yard by higher and closer piling.

Fig. 4 shows a magnet almost obscrued by steam rising from the boiling water from which it got its load. Two casting machines discharge red hot pig iron into this pit and it is sprayed with cold water but is lifted out and loaded on cars long before it cools. This magnet did this work for over three years. It was a hard job and as there was no quickly available substitute method the magnet had to be relied upon. Owing to the scale on the pig it was very hard to keep the sewer clear so about a year ago another method of cooling and loading the pig iron was installed and the magnet was transfered to other work.

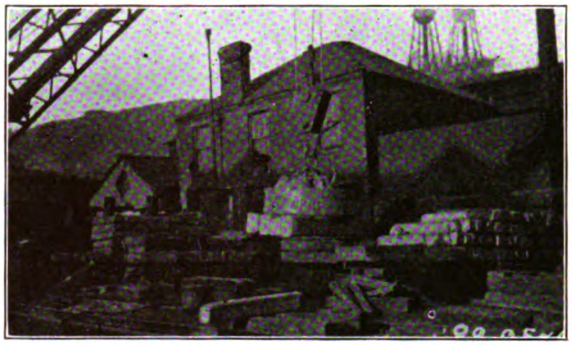


FIG. 2—*8" x 8" billets transferred by electric magnet, 40" diam.*

Two special magnets built for rail handling are operating lifting thirteen 90-lb. rails, 40 ft. long, weight 15,500 lbs. Nine are used in the rail mill of the Inland Steel Company, Indiana Harbor, Ind. They are distinctive because of their low head room, relatively light weight and because their design eliminates any chance of the parts working loose. Such work could not be done economically in any other way.

An interesting example consists of a small magnet on a rotating arm mounted so that when in its low position the magnet was energized and touched the surface of a galvanizing trough and picked up a load of pipe fittings and the excess spelter drained off as the arm rotated further. The coil was controlled by a drum switch on the same shaft and when the magnet reached the horizontal position current was cut off and the load of galvanized fittings dropped into a waiting barrow. This application not only saved labor cost but eliminated a hand job very injurious to health.

In another plant two magnets on a spreader beam pick up angles which have just been galvanized and lower them into a trough of water to cool them and wash away the excess of amonium chloride.

A magnet with special lead support is now being built for Trumbull Steel Company of Warren, Ohio, to be used solely to rescue coils of strip steel which occasionally fall off the racks in the acid tank. The acid is six feet deep. They hope of course to use this magnet as little as possible but know that it will pay well.

These are but a few of innumerable examples illustrating the labor saving ability of magnets and when we think of the hordes of men who used to sweat in the service of each open hearth furnace we realize that without the crane, the charging machine and the magnet, present day steel output would not be possible at any price.

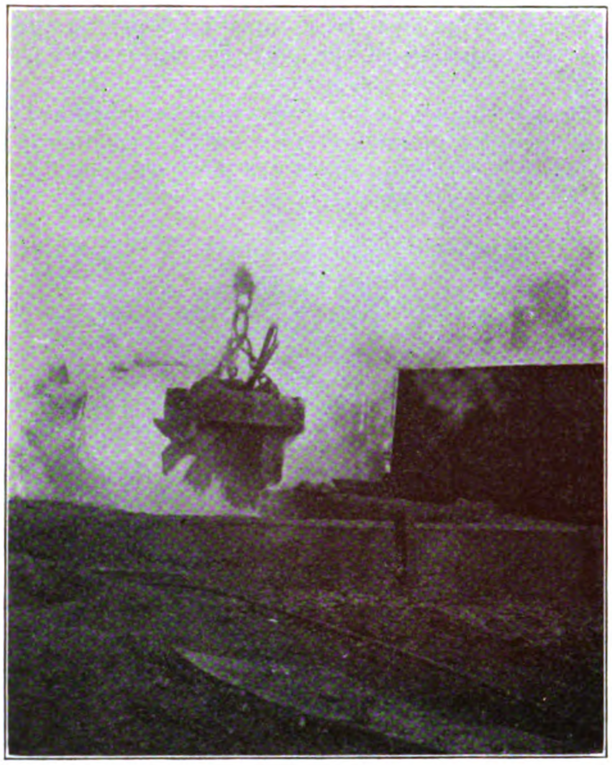


FIG. 4—*A safe method of withdrawing pig iron from Spray-pit.*

CAPACITY OF MAGNETS SHOWN IN ACTUAL SERVICE

Lifts of 2-20-in. Magnets at Kelly & Jones Co., Chicago.

No. of Pipes	Diameter In.	Length Ft.	Weight Each Lbs.	Total Weight Lbs.
1	12	20	900	900
1	10	20	823	823
2	8	22	500	1000
2	6	22	422	844
3	5	22	326	978
4	4	22	239	956
6	3	22	168	1008
7	2½	22	128	896
4 bundles (3 to bundle)	1½	22	60	720
4 bundles (3 to bundle)	1¼	22	50	600
4 bundles (6 to bundle)	1	22	37	888
4 bundles (12 to bundle)	½	22	18.7	895

Egyptian Market for American Steel Products

America's share in the iron and steel trade of Egypt has been built up since the war to such an extent that a permanent position in this line is assured, says G. E. Phoebus, of the Iron and Steel Division of the Department of Commerce. The consumption of iron and steel products by Egypt has been steadily increasing. All such products must be imported.

The year 1922 witnessed an uphill struggle for British steel manufactures in their efforts to maintain their influence with Egyptian purchasers, according to the British commercial agent for Egypt, who claims that competitors of the low currency countries held tremendous advanages. Belgium was the principal source of supply in 1922, far outstripping Germany, which came next. The United States was third from a standpoint of quality, shipments from the United Kingdom weighing considerably less although valued higher. The fact that the United States has been able to maintain its volume of trade in this market at a time when continental nations held unusual price advantages should be of great satisfaction to American steel exporters.

Appointed to National Research Council

William J. Merten, metallurgical engineer of the Westinghouse Electric & Manufacturing Company, has been appointed a member of the Committee on Heat Treatment of Carbon Steel of the National Research Council and has also been elected chairman of the Pittsburgh chapter of the American Society for Steel Treating.

Both honors have been given to Mr. Merten because of his accomplishments in the metallurgical field and are evidences of recognition of his work by metallurgists and metallurgical organizations. His appointment to the Committee on Heat Treatment of Carbon Steel of the National Research Council, which is also known as the Henry M. Howe committee, is for a period of three years, and his election as chairman of the Pittsburgh Chapter of the American Society for Steel Treating is for the ensuing year.

Mr. Merten was born June 21, 1876, at Essen, Rhineland, Germany, and was graduated from the public schools of that city. After leaving the public school, he served an apprenticeship course at the Krupp gun works and later was graduated from a a German technical school in mechanical engineering. He came to America in 1899 and worked as a machinist, foreman and inspector, respectively, for the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., the Westinghouse Machine Company, East Pittsburgh, Pa., and the Union Switch & Signal Company, Swissvale, Pa.

In 1912 he was graduated from a course in metallurgical engineering at the Carnegie Institute of Technology, with the degree of Bachelor of Science. He completed a postgraduate course in commercial engineering in 1914 and received the professional degree of Metallurgical Engineer in 1916.

In 1912 Mr. Merten installed and developed the metallurgical and chemical departments and laboratories at the Union Switch & Signal Company, being employed as metallurgical engineer and chemist. On January 1, 1916, he took charge of the metallurgical chemical laboratories and divisions of the Firestone Steel Products Company, Akron, Ohio, as metallurgical and chemical engineer In March, 1918, he went to Stillwater, Minn., to plan, install and superintend a shell heat treating plant and to supervise furnace operations in shell forge and drop forge plants and he also took charge of electric furnace melting for the Twin City Forge & Foundry Company. After this plant was closed down, he became assistant pany.

Mr. Merten is a prolific writer on metallurgical, chemical and mechanical engineering subjects and has been the author of numerous articles which have appeared in The Blast Furnace and Steel Plant, Forging and Heat Treating, technical magazines, trade papers and engineering journals.

He is a member of the American Institute of Mining and Metallurgical Engineers; the American Chemical Society; the Western Pennsylvania Engineers Society and the American Society for Steel Treating. He has served as chairman of the Papers and Meetings Committee, Pittsburgh Chapter, American Society for Steel Treating for two terms, 1921-1923, and was a member of the research committee of that organization for the 1922-1923 term. He was vice chairman of the Pittsburgh chapter when he was elected to the presidency of that body.

CURRENT TECHNICAL DIGEST

The Marvelous Audiometer

By measuring the hearing of a number of normal ears there has now been established a standard for the normal hearing. This is done by finding out the total number of pure tones audible to the person with normal hearing. A pure tone is one in which there is no mixture of other tones and is specified by its pitch and loudness. The pitch is determined by the rate of vibration and the loudness by the intensity of the vibration.

These findings are plotted on a chart as shown in Fig. 1. The lower line is established by finding the lowest intensity at which the tones can just be heard. The tones are spaced an octave apart on the musical scale.

The question naturally arises in the reader's mind as to how many pure tones are audible to the normal ear. It has been determined that at high C, or C3, there are 270 gradations of volume which can be sensed one from the other. At the line of intensity or loudness designated as 10 dynes at the left side of the chart) 1,500 tones can be perceived as having different pitches. If the ear were equally sensitive to all pitches and intensities within its range the total number of pure tones perceptible to the normal ear would be the product of these two numbers or 405,000 tones. But as the ear is not as sensitive to the higher and lower tones there are 300,000 sounds which are audible to the normal ear.

One of the distinct advantages of this method of measuring the hearing is that it is possible to find out just what tones cannot be heard. This gives the doctors a very good clue as to what is causing deafness. It may then be possible to remove the cause and in some cases restore normal hearing to the afflicted one.

The audiometer is very useful in court cases. Considerable confusion exists in courts where the degree of deafness is involved as there are a number of laws which prevent people with poor hearing from engaging in certain classes of work. For example, one cannot operate an automobile if he has a certain degree of deafness. At the present time there is a large variation between the standards set up by the various doctors in the different parts of the country. The audiometer measures deafness with such accuracy that there is little chance for dispute.

The audiometer which has made possible such accurate measurements of the hearing is composed of vacuum tubes, thermal receivers and condenser transmitters. By a proper arrangement of circuits, the vacuum tube is capable of generating an oscillating electrical current of any desired frequency. This electrical vibration is transferred into sound vibration by means of a telephone receiver. Between the receiver and the oscillator, a wire network called an attenuator is interposed which makes it possible to regulate the

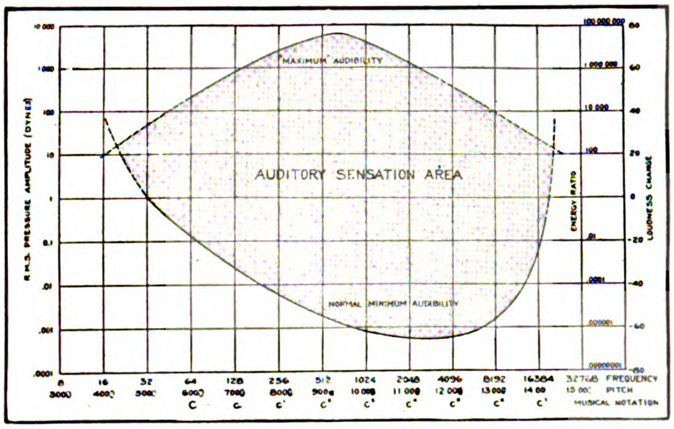


FIG. 1—*Diagram showing the area of normal hearing. This chart compares with those on Fig. 2 which shows examples of abnormal hearing.*

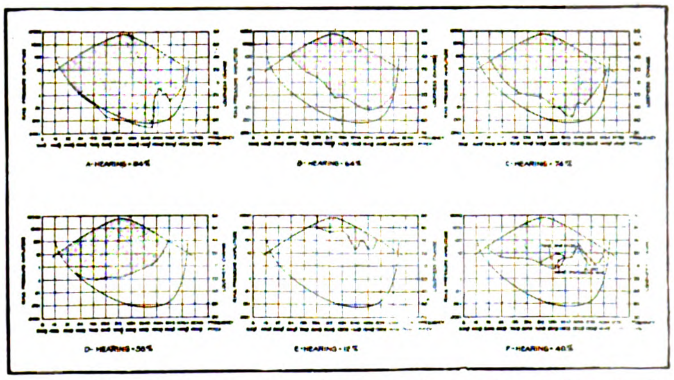


FIG. 2—*The shaded portions in these charts show what the individuals can hear. It was possible to plot these charts with the aid of the audiometer.*

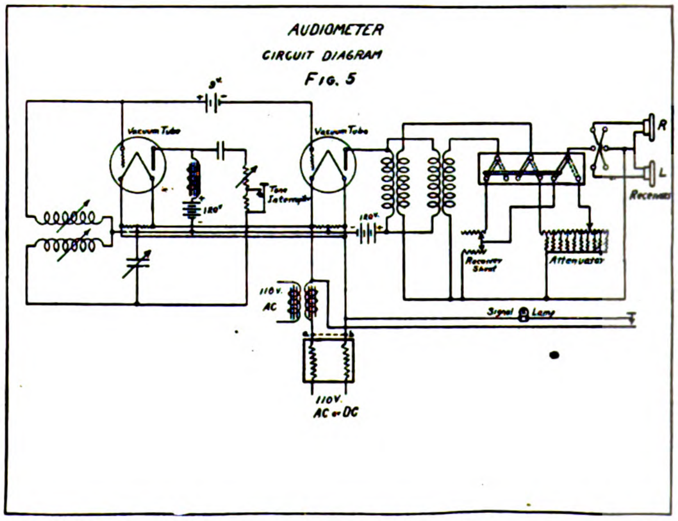


FIG. 3—*If you are a radio fan, you can see at a glance at this chart how the audiometer operates.*

volume of sound. The theory of the thermal receiver has been worked out so that it is possible to calculate its acoustic output from the electrical energy it is absorbing. In this way it is possible to calculate the pressure produced in the outer ear canal when a tone is being perceived. When calibrated this apparatus is called an audiometer.—Western Electric News.

Engineering Romance Devises World's Rarest Power Plant

A romance in engineering adventure is interwoven with the contract recently acquired by the I. P. Morris shops of the William Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa. Before it will be possible to complete the comparatively small installation of a 500 hp. electric plant in the little city of Manizales, Republic of Colombia, one hundred miles from the nearest railroad and at the bottom of a deep canyon of the Andes, in what is regarded as the wildest country in South America, it will be necessary to achieve some novel feats of mechanical skill.

It is not the fact altogether that to transport this equipment to the progressive though isolated little community, but every ounce of it must be transported the hundred miles by wagon, by muleback and aerial tramway through and over the mountain passes which lends zest to this novel development. The greatest difficulty to be overcome, from many angles, is the fact that the only power available with which the plant could be operated when constructed was to be derived from a mountain torrent not far distant from the Andean city. But it was discovered that the water there was so heavily impregnated with sulphuric acid as to make it impossible to expose any steel of whatever grade to it without incurring its complete and speedy dissolution. As a consequence, the resourcefulness of the Morris plant was called into play, with the result that a special metal was devised of compounds and from this the machinery will be built. So far as is known, this is the only power plant in the world to be operated on dilute sulphuric acid.

The Pelton design of impulse wheel consequently is being worked out on a basis which permits the use of bronze, brass and Monell metal, instead of steel, at every point that would be exposed to the water. This may be successfully accomplished, as well as the companion task of sectionalizing the entire equipment for transportation in small pieces and assembling on the spot, without prejudice to the strength or efficiency of the whole installation.

From Philadelphia the machinery will go by steamer to the Magdalena River, up the Magdalena by river craft to the railroad, by rail to the end of the line, and thence to Manizales. The last stage of the journey will be the most difficult of all.

The Manizales plant can be reached directly only by aerial tramway. When this tramway ride has been completed, it will still be necessary to lower the machinery down the slope of the gorge on a skidway to the point where it will finally be put in commission.

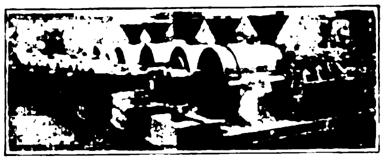
—Commerce and Industry.

Powdered Coal in England

The Engineering Review of London, in its April issue abstracts a paper read by T. T. Dunn, D. Sc., F. I. C. before the Northeast Cost Institute of Engineers and Shipbuilders.

A typical installation for the burning of powdered coal includes arrangements for (a) breaking, (b) drying, (c) pulverizing the coal, (d) transporting it to the furnace, (e) feeding it through the burner. The systems in use divide themselves sharply into two: (1) The unit system, in which the coal is pulverized at the furnace, so that there is a separate pulverizer for each furnace; (2) the multiple system, in which the coal is pulverized at a center and transported as a powder to any number of furnaces that may be included in the installation.

The unit system is very compact, and is very useful where the installation is small and would not justify the capital outlay for a separate pulverizing installation and transport system; but the cost of course increases almost proportionately with the number of furnaces to be fed. Another advantage is that unless the raw coal be very wet it can be used in the pulverizer without preliminary drying, for there are no great lengths of piping, no bins nor feed-screws, and hence there is little likelihood of clogging of wet coal occurring. The turbo-pulverizer does not pulverize the coal so finely as some of the pulverizers in other systems (in one instance 70 per cent passed a 1/100-inch), but the fineness is sufficient to ensure practically complete combustion of any ordinary coal. Nearly all the air needed for the combustion of the coal is drawn in by the fan and mixed with the coal before it reaches the burner; and it is possible to secure smokeless combustion with a great variety of coals.



A consignment of turbo-pulverizers made to the order of the Nizam of Hyderabad for firing water tube boilers.

In the multiple systems the first step, as in the unit system, is the crushing of the coal. Before pulverization, however, the coal is in all these systems dried to such an extent as to leave not more than 0.5 to 1.0 per cent of moisture in it. Not only is finer pulverization secured by using dry coal, but the risk of stoppages, caused by the clogging of the powder and its sticking or hanging in the pipes, conveyors, valves, or storage bins, is very greatly lessened. In nearly all the systems the drier consists of a long inclined cylinder, which rotates slowly on its axis, and down which the coal slowly travels. The cylinder is heated on the outside by a small furnace near one end, and the flue gases, after traveling along the outside of the cylinder and becoming cooled to a temperature at which it is safe to bring them into contact with the coal, then travel through the inside, and carry with them the water vapour which the coal gives off.

From the drier the coal goes to the pulverizer. Much stress has been laid on the need for extremely fine pulverization. Whether the unit system or the multiple system is adopted certain advantages and disadvantages must be weighed against each other.

Advantages.

(1) Better combustion.

(2) Easier regulation. The speed of entry of the fuel, and the proportions of fuel and primary or secondary air, can be varied readily.

(3) Rapidity of starting and stopping. The full flame is at once available on starting, and the heating up of a furnace starting from cold is much more rapid than with solid fuel.

(4) Use of inferior fuels.

Disadvantages.

(1) Ash. In solid-fuel furnaces, the ash remains on the hearth; but with powdered fuel it is first formed as a fine suspended dust, which will tend, of course, to settle out, but from its fineness will largely be carried on with the products of combustion and be liable to deposit on boiler tubes, on the objects to be heated in the furnace, or in regenerator chambers if there be any such.

(2) Refractory materials; here again, early experience showed that the high temperature of the flame was very destructive of furnace linings, the bricks melting down under the combined influence of the high temperature and the mechanically abrasive and chemically destructive action of the ash particles which scoured along them; but the same improvements, and the device of introducing a little excess air along the walls of the combustion chamber, have greatly mitigated the evil. The production of refractory linings of higher melting point and greater chemical resistance would, however, be of great assistance in powdered fuel fired, as in oil fired installations.

(3) Explosion. Much has been made of the fact that a mixture of coal dust and air in certain proportions is explosive, and the explosions have occurred in powdered fuel plants. But investigation has shown that these explosions have in all cases arisen from causes which were preventible, and not inherent in the nature of the operations carried on in the plant; and the possibility of explosion in a well-designed plant which is properly inspected and kept in order is very remote.

Costs. It is very difficult to obtain trustworthy figures of the cost of powdered fuel equipment which will hold good in this country; nearly all of those which are published are of American origin, and not many of those afford basis for comparison with the cost of working similar furnaces in solid fuel. The following figures, kindly supplied by Messrs. Edgar Allen and Company, Ltd., of Sheffield, afford a comparison between two reheating furnaces, one worked with powdered coal, the other with solid fuel, over a period of four months of intermittent work, and over a week:

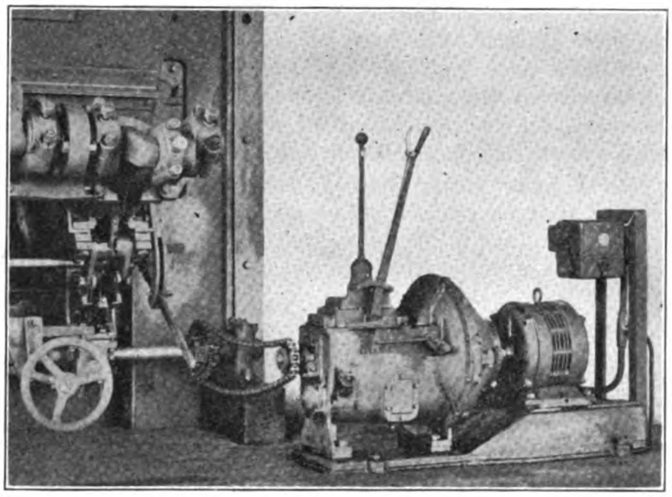
	Solid Fuel	Powdered Fuel
Turns worked........	65¾	65¾
Steel heated..........	104 tons	163 tons
Slack or coal used.....	71 tons	64 tons
Slack per ton of steel..	13.75 cwt.	7.85 cwt.
Cost of fuel..........	£126 2s. 0d.	£55 15s. 7d.
Cost of motor........	......	£32 17s. 6d.
Cost of wages........	......	£19 4s. 0d.
Total cost per ton of steel	£1 15s. 6d.	13s. 3d.
Turns worked........	6	6
Steel heated..........	9 tons, 9 cwt.	16 tons, 10 cwt., 3 qrs.
Fuel used............	7 tons	5 tons, 12 cwt., 2 qrs.
Fuel per ton of steel...	14.8 cwt.	6.8 cwt.
Cost of fuel..........	£13 0s. 0d.	£5 4s. 0d.
Cost of motor........	......	£2 12s. 0d.
Cost of wages........	......	£1 6s. 3d.
Total cost per ton of steel	£1 7s. 0d.	11s. 1d.

(5) Saving in labor. In large installations especially there is a marked saving in labor effected by the use of powdered fuel.

Truck Transmission Drives Stoker

In the selection of a stoker drive many important considerations have to be estimated. It is to be remembered that the modern stoker is primarily a constant torque machine, regardless of the speed at which it runs.

To meet this primary condition—automobile practice has been resorted to in a most practical way. The standard truck transmission — three speeds forward and one reverse has been adopted. A compact form of 2-1 variable speed induction motor can in this way operate without the usual speed-changers. The combination insures a continuous speed range of 10.7 to 1. A clutch is provided so that motor can operate while any combination of gears is made. All bearings are roller type and spur gears are used, making the efficiency of the drive high.



Novel stoker drive.

In this connection, the relative advantages of a.c. and d.c. stoker drives may be discussed. Alternating current motors are most largely employed—but direct current installations show higher operating efficiencies.

Calculation for the power requirements are not easily made, and if the armature resistance is calculated on a certain speed—torque curve, which does not happen to obtain in actual stoker operation, the resistance grids will probably have to be changed. "Wearing-in" of the stoker castings may also effect the result. Shunt-wound d.c. motors with all field control seems to possess all the requirements for this service.

The following table of efficiencies, using a 15 hp. motor operating at torque equivalent to 10 hp. at full speed is of interest:

Speed Rpm.	D.C. Motor and Control, Per Cent	A.C. Motor and Control, Per Cent
1,200	82	79
1,000	80	68
800	78	54
600	76	79

500	74	68
400	72	54
300	70	40

—Power, June 3, 1923, pages 8-9.

INSTITUTE DIRECTORS

Assure President Harding That Twelve-Hour Shift Will Be Abolished at Earliest Time Practicable—Judge Gary Gives Views and Answers Questions.

At Tacoma, Wash., July 5, President Harding made public recent correspondence which he had had with Judge Elbert H. Gary, president of the board of directors of the United States Steel Corporation, in regard to the abolition of the twelve-hour day in the steel industry.

The President's letter to Judge Gary was as follows:

The White House, June 18, 1923.

My dear Judge Gary:

I have now had an opportunity of reading the full report of the commissions of the Iron and Steel Institute on the question of the abolition of the twelve-hour day in the steel industry.

As I have stated before, I am of course disappointed that no conclusive arrangement was proposed for determination of what might be manifestly accepted as a practice that should be obsolete in American life and institutions.

I am impressed that in the reasoning of the report great weight should be attached to the fact that in the present shortage of labor it would cripple our entire prosperity if the change were abruptly made.

In the hope that this question could be disposed of I am wondering if it would not be possible for the steel industry to consider giving an understanding that before there shall be any reduction in the staff or employes of the industry through any recession of demand for steel products, or at any time when there is a surplus of labor available that then the change should be made from the two shifts to the three shift basis.

I cannot but believe that such an undertaking would give satisfaction to the American people as a whole and would indeed establish pride and confidence in the ability of our industries themselves to solve matters where so conclusively advocated by the public.

With very cordial expression of personal regard, I am,

Verly truly yours,
WARREN G. HARDING.

Response of the Directors.

The letter from 15 of the 23 directors of the institute was as follows:

New York, June 27, 1923.

To the Honorable Warren G. Harding, President of the United States:

Dear Mr. President:

Careful consideration has been given to your letter of June 18 by the undersigned directors of the American Iron and Steel Institute, comprising of all those whose attendance could be secured at this time.

Undoubtedly there is a strong sentiment throughout the country in favor of eliminating the twelve-hour day and this we do not underestimate. On account of this sentiment, and especially because it is in accordance with your own expressed views, we are determined to exert every effort at our command to secure in the iron and steel industry of this country a total abolition of the twelve-hour day at the earliest time practicable. This means the employment of large numbers of workmen on an eight-hour basis and all others on a basis of 10 hours or less without an unjustifiable interruption to operations.

The change cannot be effected overnight. It will involve many adjustments, some of them complicated and difficult, but we think it can be brought about without undue delay when, as you state it, "there is a surplus of labor available."

The iron and steel manufacturers generally of the United States, outside of the directors referred to, are expected to concur in the conclusion reached by the directors as above stated.

With highest regards, we are cordially yours,

Elbert H. Gary, John A. Topping, W. A. Rogers, W. H. Donner, W. J. Filbert, E. A. S. Clarke, James A. Farrell, E. G. Grace, Willis L. King, James A. Burden, L. E. Block, Severn P. Ker, J. A. Campbell, A. C. Dinkey, Charles M. Schwab,

Directors American Iron and Steel Institute.

—Iron Age for July 12, 1923.

Commenting editorially on the same important subject, in July 19th issue. The same magazine states:

"Evidently the labor union leaders who have aimed for years to get control of the steel industry and of the thousands of its workers who will not, if they can help it, submit to such control, are satisfied that the end of the twelve-hour day is in sight. One week ago they announced the starting of a new campaign to unionize the steel workers so as to secure the eight-hour day. Today they are assuring newspaper readers that they will not cease their efforts to organize the steel industry, "even when the eight-hour day is established there," and "when the funeral of the twelve-hour day finally comes we will rightly take credit for it."

In all the reports outside engineers have made on two-shift operations at iron and steel works it has been said repeatedly that progress toward the shorter day must be gradual. Such engineers have pointed out also that the co-operation of the men must be secured. That has been taken for granted in the theoretical views of the subject that have filled the daily press but the fact is that not only workers themselves, but wives and mothers of workers—not ignorant and foreign born, but in many cases of American bringing up — have been heard time and again in protest against short working time, and this not more on the score of a lessened week's wage than of the untoward consequence of the long periods of idle time. The men know, if some uninformed writers do not know, that the hours, actually worked in the twelve-hour shift in blast furnace operation have averaged in the case of one of the largest companies exactly 5.7 or less than 50 per cent of the nominal working time. There is good reason, therefore, for saying that one of the factors in bringing about the change will be the time required to secure the co-operation of the men. No little difficulty will be met with, in the case of the tonnage men, who, in compensation for the loss of tonnage will naturally seek a higher tonnage rate.

In open-hearth operations the problems presented, owing to the varying demand for the different forms of service, at intervals in the 24-hour period, are extremely intricate. Some of the proposals now brought forward involve for some classes of workers off-and-on periods, with considerable variations from straight eight-hour turns. Thus the wrenching of working times to which men have grown accustomed in many years of service will be so severe in many cases as to make the greatest problem of all that of inducing the worker to stay with the industry.

But with all its difficulties and consequences, for good and for ill, the coming in of the shorter day in iron and steel making is close at hand. Public sentiment, partly informed and largely uninformed has called for it, regardless of economic consequences, but convinced apparently that the change will bring great social benefits. Steel workers and the tens of thousands of men and women who own the steel plants of the country may find the mandate of the public hard to bear, but the leaders of the industry have set their hands to the task and there will be no turning back.

On pages 129-132, W. C. Buell of Pittsburgh presents a novel and interesting instance of a recent application of heavy-fuel oil to heating furnaces.

This installation was made at the plant of Hubbard & Company, Pittsburgh, manufacturers of electrical pole line equipment, railroad tools, shovels, etc. In the various departments of this plant, which is of considerable extent, natural gas, oil and pulverized coal are used for fuel. A short time ago Hubbard & Company decided to segregate the bulldozer operations of the electrical materials department, and for this purpose erected a brick, steel and glass monitor type building 60 ft. by 160 ft.

When the engineers took over the design of the projected oil systems, furnaces and machine layout, it was found impossible to locate the oil, steam and air piping in trenches under the floor, as is most desirable, owing to the fact that the concrete floor was in place. Accordingly, all the piping was placed overhead, supported on the roof trusses.

It was arranged that 12 bulldozers, each with its furnace, should be installed, six sets on each side of the building. The general layout of that side of the plant which includes the fuel system is shown in Fig. 1. This picture was taken with only two of the six machines on their foundations. The hood at the top of each furnace was later connected to a common stack for the removal of heat from the fires, and the oil system at the left was inclosed with expanded metal.

Furnaces.

The furnaces were very simply constructed of steel shapes and fire brick, as shown in Fig. 2. Their inexpensive rugged construction and the absence of cast iron are notable. The "bung clamps" A are cast steel and the rods B of bolt stock. Every reasonable effort was made to design the furnaces so as to give the operators the maximum protection from the heat; notice the hood and the double shields at both sides.

Oil Burners.

Oil burners supplied by George J. Hagan Company, Pittsburgh, and of an advanced type (Fig. 3) were used, two being applied to each furnace. The choice of burners was based on: (a) the method of circulating fuel through the oil head of the burner (patented), (b) the method of adjusting air and fuel at the burner tip instead of at a point remote from the point of mixing and (c) the secondary air adjustment shutter which permits the character of the flame to be controlled through wide limits.

System for Heavy Oil.

The writer is firmly convinced that the present common use of light fluid fuel oils will be greatly curtailed in the near future.

It is conceded that generally an air pressure of 1 or 2 lb. per sq. in. brings about the most economical fuels properly conditioned. The blower is a 25-hp., 3-stage turbine type machine, designed to deliver 2250 cu. ft. per min. at 1½ lb., and with an oil burning capacity of 135 gal. per hr.

Oil Storage.

Ample oil storage for 15-day supply is provided adjacent to the building.

Thermostatic control on the steam, which is adjustable within a considerable range, permits the temperature of the oil flowing in the suction line to the pump to be maintained constantly at a selected temperature and, as oils available for fuel seldom require heating to temperatures over 100 deg. F., for good pumping conditions, this is the usual suction oil temperature.

Installed as described above, the system will work continuously with slight attention. Starting and stopping, which means throwing two electric switches, requires the attention of an operator, but aside from that and occasionally cleaning the strainers and giving the moving parts of the equipment the proper inspection and oiling, no other attention is required. All waste steam lines are trapped and all steam and oil lines are insulated, which in conjunction with the thermostatic controls allows proper heating from the minimum steam.

As there is always hot fluid oil at the burners, the furnaces, even after a shutdown of several days in cold weather, may be started easily and quickly.

Advantages of Heavy Oil.

Heavy oils offer the user:

(a) A considerable differential of price per gallon, often 20 per cent or more.

(b) A considerable increase in calorific value: note the figures following, and further that the difference between 10 deg. Beaume and 30 deg. Beaume in this particular respect is 9 per cent.

10 deg. Beaume, 156,686 Btu. per gallon.
15 deg. Beaume, 153,198 Btu. per gallon.
20 deg. Beaume, 149,783 Btu. per gallon.
25 deg. Beaume, 146,760 Btu. per gallon.
30 deg. Beaume, 143,550 Btu. per gallon.

—Iron Age for July 19, 1923.

Following is a brief summary of some of the principal articles and market reviews appearing in "Iron Trade Review," June 28 and for July to date:

June 28—

Prospects for the steel industry at the beginning of the second half of the year appear to be exceptionally good; the mills being sold months ahead, tonnage being rapidly absorbed and new buying increasing. In the pig iron market, however, business continues in very small volume. Iron Trade Review composite of 14 leading iron and steel products this week is $46.16, compared with $46.34 the week preceding.

A series of articles under the caption, "Which Way Is Business Headed?" and writen by Iron Trade Review's financial editor is begun with this issue, setting up the constructive features and unfavorable elements appearing in commercial and manufacturing lines.

The new plant of the Weldless Tube Company at Wooster, Ohio, for the making of small seamless tubing is described. An article from Iron Trade Review's European service gives an account of the annual meeting at Manchester of the Institute of British Foundrymen. The new intercoastal rates on iron and steel products from Atlantic to Pacific ports are given in detail.

July 5—

Production and shipments of pig iron and steel continue in heavy volume though there are more indications of a reduction in new business. A continued decline in pig iron prices has depressed the composite of 14 leading iron and steel products to $45.72. June showed a daily output of 122,450 tons of coke iron, compared with the high mark of 124,790 tons in May, the June total being 3,673,503 tons as against 3,868,486 tons in May.

Some recession is noted in the volume of business in the British iron and steel market, British bookings now averaging 60 per cent of their output. German prices continue to be advanced correspondingly with reductions in the value of the mark. Cammell, Laird & Company, large British steel makers and shipbuilders, are merging with the Leeds-Forge, important builders of railroad equipment. The purchase of Steel & Tube Company of America properties by the Youngstown Sheet & Tube Company is completed by official announcement by President J. E. Campbell.

The financial and commodity markets display more weakness, the decline in stocks wiping out all gains since spring 1922.

The effect of carbon on chromium steels is set forth in a paper presented before the London meeting of the Iron and Steel Institute by Charles R. Austin, associated with University College, Swansea, Wales. A comprehensive system for keeping of time and payroll records in iron and steel plants, with numerous forms, is given. The American Society for Testing Materials in annual convention at Atlantic City prepares plans for greatly extending its research work.

July 12—

Merchant blast furnaces begin to go out as buying lags and over-production appears. New buying of steel, while below shipments, still constitutes a fair tonnage. Steel ingot production in June was 3,748,890 tons, the smallest since February; and for the first half of the year the production was 23,213,243 tons, or over 46,000,000 tons annually, a high record. A composite of 14 iron and steel products now is down to $45.49. Pig iron prices continue to recede, but quotations on finished steel are holding firm. All steel bars are raised, the full extent of the revisions being given in this issue.

A more critical situation is developing in the British iron and steel market, consumers failing to buy despite the continued descent of prices. French mills take an order for 30,000 tons of rails for Argentina. Efforts are revived to establish a European steel sale combination.

The directors of the American Iron and Steel Institute give President Harding their pledge to abolish the 12-hour day, when "there is a surplus of labor available," and steps are already taken by a number of the leading interests to carry this out, despite the widespread labor shortage.

July 19—

A gradual letdown in the volume of new steel business is noted, concurrent with the lessening demand for pig iron. Independent sheet sale fell to 63.7 per cent of capacity. Building awards show some revival and the railroads and oil companies still are in the market. A composite of 14 leading products this week is $45.26. Buffalo and valley foundry iron is down to $25.00. Propaganda directed against the Pittsburgh basing point practice has succeeded in enlisting the assistance of Illinois, Iowa, Wisconsin and Minnesota through their legislatures, and funds have been appropriated by some of these states.

The British iron and steel situation continues to grow worse, prices steadily failing. France, despite all of its difficulties, is managing to sell some pig iron in the United States. German prices are extraordinarily low expressed in American currency, but exports have practically ceased due to stringent regulations and manufacturing difficulties. The business trend charts show that industrial activity is lessening.

Secretary of Commerce Hoover presents a defense of trade associations. The steamer Charles M. Schwab for carrying iron ore on the Great Lakes is launched at Cleveland. The death of Capt. Robert W. Hunt, one of the deans of American iron and steel industry, at Chicago, July 11, is announced.

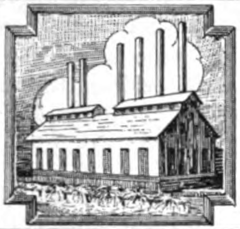
July 26—

A better situation is developing in the steel market, buyers calling for heavier tonnages. The pig iron market also shows some signs of strengthening. New York reports sales of 30,000 tons and the Valley and other centers fair totals. A decline in prices has been slowed down, a composite of 14 leading products being $45.26 this week.

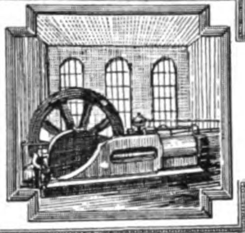
Business in the British iron and steel markets is halted by political confusion growing out of the Ruhr controversy, and still lower prices are quoted.

The fabrication of large storage tanks and a description of a prominent fabricator's plant in the Pittsburgh district is given by Mr. John D. Knox, associate technical editor at Pittsburgh of Iron Trade Review. A new electrically operated bar mill in the State of Washington begins operations, the plant being described.

A condensed record of seven years' statistics pertaining to labor disputes as compiled by the Federal Bureau of Labor is given in this issue.



STEAM POWER DEPARTMENT



Insulation in Power Plants

Simplest and Cheapest Method of Recovering and Preventing Avoidable Heat Wastes—Extent of Losses Seldom Realized.

By L. B. McMILLAN*

THE greatly increased cost of fuel during the past few years has done more than anything else to focus attention on preventable waste in industry. Of all the preventable fuel wastes in power plants, that due to excessive radiation losses is perhaps the one most easily and definitely corrected. The extent of such losses is illustrated by the fact that one square foot of surface at a steam temperature corresponding to 150 pounds pressure loses about one-half ton of coal per year. It is possible to save about 90 per cent of this loss by the use of suitable insulation.

The time has long since passed when long lengths of bare steam pipe gave engineers and managers little concern. With ever increasing costs of fuel these could not be tolerated.

It is only comparatively recently, however, that sufficient consideration has been given to insulating flanges and fittings and to correct thicknesses of insulation, and the day has not yet entirely passed when an engineer is satisfied if his steam lines are just "covered." However, he is coming more and more to the realization of what it means for the pipes to be really "insulated" and not merely covered.

The distinction between these terms is more marked than may be readily apparent. A pipe may be "covered" with a material of low efficiency or one which, through lack of durability, has lost its efficiency due to breakage of fragile material, etc., which allows the air to circulate through and carry away heat. On the other hand, an "insulated" line is one on which the material is not only highly efficient, but also is properly suited to the conditions both as to durability and correct thickness.

Perhaps the most notable advance in this direction has been the replacement of rule of thumb methods by exact knowledge regarding what various materials and different thicknesses of these materials will accomplish, and what the actual losses are if surfaces are not insulated.

For example, Table 1 shows the heat losses per square foot of uninsulated surface per hour at various temperatures. It also shows the number of pounds of coal wasted per square foot of hot surface per year and the number of square feet of this surface which will waste a ton of coal per year under the given conditions.

From the data shown in this table it is apparent that even relatively small areas of bare heated surface may cause the waste of excessive quantities of fuel. Flanges are frequently left bare on the ground that the loss is not sufficient to warrant insulation. However, on a pipe carrying steam at 100 pounds pressure a pair of 10-in. flanges have sufficient area to cause the loss of more than a ton of coal per year.

The radiation areas of bare standard flanges are given in Table 2 for different sizes of pipe and the use of this table in connection with Table 1 will show how great are the losses if flanges are not insulated.

Table 3 shows the heat losses from a number of different commercial pipe covering materials of approximately 1 in. thickness and at various temperature difference between steam and air surrounding the pipe of from 100 deg. to 500 deg. F.

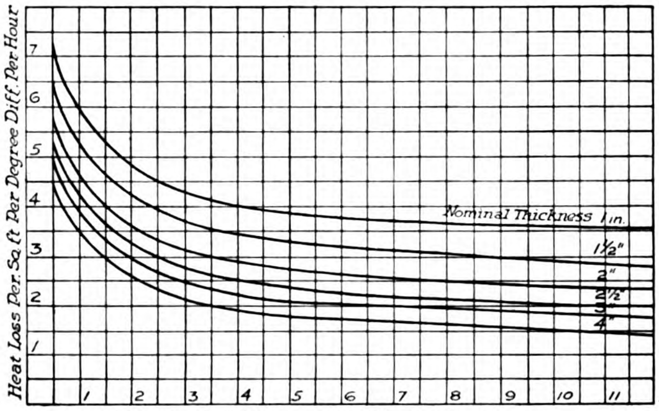


FIG. 1—*Graphic illustration of heat losses through various covering thicknesses.*

Fig. 1 shows how the losses vary for different thicknesses of material on the same pipe size and for the same thickness on different pipe sizes. It will be noted that the pipe size is a very important item in determining what the loss through insulation will be; because on the smaller pipes the losses per square foot through a given thickness of insulation are much greater than on the large ones.

Table 4 shows approximately the thicknesses of insulation which should be used for best results at various steam pressures and temperatures and for different sizes of pipes. For flat surfaces, sheet or block material of the same thicknesses as for the larger pipes may be used, but in addition there should be a finish of ½-in. to ¾-in. of Asbestos Cement applied in two coats.

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*Consulting Engineer, New York City.

TABLE 1—HEAT LOSSES FROM UNINSULATED HOT SURFACES

Ordinary Steam Temperatures; Temperature of Surrounding Air, 70 Deg. F.

Steam pressure (gage), lb.	Steam temperature, deg. F.	Difference betw. temp. of steam and surrounding air, deg. F.	Loss per sq. ft. per hr. Btu.	Waste of coal in lb. per sq. ft. per year	No. of sq. ft. of surface that wastes ton of coal in 1 year
0	212	142	334	293	6.82
10	240	170	425	372	5.38
25	267	197	522.5	458	4.37
50	298	228	644	564	3.55
75	320	250	737.5	646	3.10
100	338	268	820	718	2.79
150	366	296	960	840	2.38
200	388	318	1079	945	2.12
250	406	336	1184	1036	1.93

Temperatures Lower Than 212 Deg. F.

Surface temperature, deg. F.	Difference betw. temp. of surface and surrounding air, deg. F.	Heat loss per sq. ft. per hr., Btu.	Waste of coal in lb., per sq. ft. per year	No. of sq. ft. of surface that wastes 1 ton of coal in 1 yr.
100	30	56.6	49.6	40.3
120	50	97.5	85.4	23.4
140	70	142	124.3	16.1
160	90	190	166.3	12.03
180	10	242	212	9.44
200	130	298.5	261.5	7.65

Above figures involving waste of coal are based on the following:

10,000 Btu. available per lb. of coal, which is equivalent to a boiler efficiency of 70 per cent, using coal with an assumed heating value of about 14,000 Btu. per lb.

These figures are very conservative, as both the boiler efficiency and the heat value of the coal are high—a lower boiler efficiency or inferior grade of coal would cause even a greater waste in pounds of fuel.

This table is intended only as an approximation and the proper thickness for a given condition should be checked up by finding the saving in dollars per year effected by a contemplated additional thickness of insulation and determining if this saving pays a satisfactory return on the additional cost. The need for a careful checking of this kind is especially great in case of a very expensive source of heat as from electricity, etc.

The insulation of boiler walls is a comparatively recent development and is a field of increasing interest at the present time. The losses of heat from bare walls of boiler furnaces cause a loss of fuel averaging from 250 to 350 pounds of coal per square foot per year and much of this loss can be prevented by the use of suitable insulation.

The loss from a boiler wall cannot be gauged by temperature alone. The loss is dependent upon the temperature difference between the surface of the wall and the surrounding air and upon the air circulation over the surface. A cool wall near the doors or windows of the boiler room may be losing considerably more heat than a much hotter one where there is less air circulation as between boilers set close together.

Neither can the loss from the wall either bare or insulated be estimated by the "feel" of the wall. In the first place, boiler room temperatures are usually rather high and the temperature of the wall, even if sufficiently insulated, will be, at the hottest point, about 50 deg. to 75 deg. above room temperature. Therefore, this amount added to room temperature will give temperatures on the wall which will feel decidedly hot to the touch. However, the real answer is that the "feel" of the wall is no conclusive evidence one way or another. A smooth, hard surface feels hotter than a rough one at the same temperature. Therefore, the reduction in temperature brought about by cutting the loss in half cannot properly be judged by the "feel" of the wall.

The most effective position for the insulation is at the outside of the wall because there it is possible to use more efficient materials than if the insulation were placed in the center of the wall where it would be subjected to higher temperatures.

Among the other advantages of using insulation on the outside of the wall are the following:

1. The use of insulating material in the form of large sheets on the outside of the wall, finished with a coat of hard finish Asbestos Cement, thoroughly and enduringly seals the wall against air leakage. The saving from this source is often as great as or greater than the saving effected by preventing radiation loss.

TABLE 2—TOTAL RADIATION AREAS OF STANDARD FLANGES

Pipe Size In.	Area Per Pair Sq. Ft.
1	.320
1¼	.383
1½	.477
2	.672
2½	.841
3	.945
3½	1.122
4	1.344
4½	1.474
5	1.622
6	1.82
7	2.17
8	2.41
9	3.00
10	3.43
12	4.41
14 O. D.	5.39
15 O. D.	6.18
16 O. D.	6.69

2. Insulation on the outside of the wall produces a more uniform wall temperature. The heat tends to flow in the wall from the intensely heated parts to those which are cooler. For that reason the temperature does not build up under the insulation to as high a point as if the flow were only straight through.

The flow of heat from the furnace to these cooler parts of the wall tends to increase to some extent the losses through the insulation on those portions, but these losses are still far less than they would be if the same portions were not insulated.

3. This more uniform temperature means that there will be less tendency for the walls to crack and bulge. It is not expansion alone so much as unequal expansion which damages walls. Without insulation the wall opposite the furnace is much hotter than the

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TABLE 3—DATA ON COMMERCIAL PIPE COVERINGS

Kind of Covering	(r_2-r_1) for materials tested (=opp.thic) inches	k* (for temp. dif. of 300 deg. F.	Btu. loss per sq. ft. per deg. temp. dif. per hour for single thickess coverings on 5-in. Pipe (=C)				
			Temperature difference (pipe and room), Deg. F.				
			100	200	300	400	500
J-M 85% Magnesia	1.18	0.507	0.381	0.397	0.413	0.429	0.445
J-M Indented	1.12	0.666	0.483	0.509	0.549	0.603	0.666
J-M Vitribestos	1.11	1.087	0.654	0.715	0.781	0.858	0.967
J-M Eureka	1.04	0.549	0.451	0.464	0.478		
J-M Molded Asbestos	1.26	0.778	0.522	0.539	0.561	0.596	
J-M Wool Felt	1.10	0.521	0.400	0.421	0.442		
Sall-mo Expanded	1.07	0.598	0.427	0.464	0.503	0.541	0.581
Carey Carocel	1.06	0.540	0.378	0.421	0.466	0.510	0.562
Carey Serrated	1.13	0.682	0.468	0.506	0.546	0.587	0.634
Carey Duplex	1.01	0.636	0.447	0.498	0.548		
Carey 85% Magnesia	1.19	0.546	0.418	0.424	0.436	0.454	0.472
Sall-mo Wool Felt	1.01	0.510	0.410	0.433	0.459		
Nonpareil High Pressure	1.23	0.543	0.402	0.412	0.426	0.444	0.465
J-M Asbestos Fire Felt	1.09	1.093	0.711	0.749	0.795	0.845	0.901
J-M Asbesto-Sponge Felted	1.16	0.466	0.347	0.369	0.391	0.414	0.439
J-M Asbestocel	1.10	0.596	0.429	0.454	0.493	0.544	0.609
J-M Air Cell	1.11	0.718	0.475	0.515	0.571	0.643	0.733
Plastic 85% Magnesia	1.05	0.567	0.470	0.488	0.505	0.522	0.539
Sall-Mo Air Cell	0.95	0.802	0.539	0.603	0.681	0.771	0.871

*k = true conductivity in Btu. per sq. ft. per hour per deg. temp. difference between surfaces per 1 in. thick.

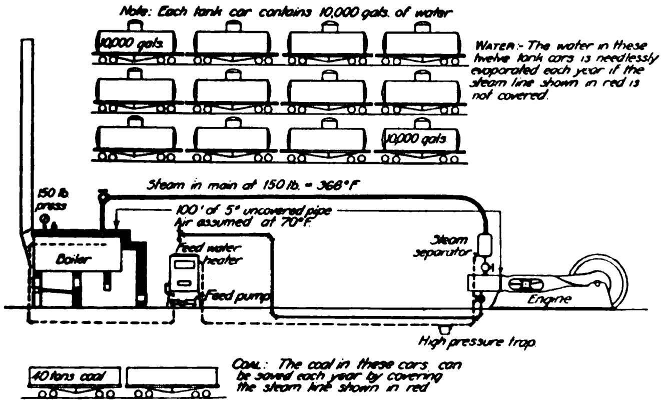
SAVED BY INSULATING

	4"	6"	8"	10"	12"	16"	20"	24"
Bare flange loss Btu. per hour	1775	2260	3067	4035	5488	7586	9523	12266
Cost of heat lost per year bare flange	$3.55	$4.52	$6.14	$8.08	$10.98	$15.18	$19.06	$24.46
Efficiency of Asbestos Sponge, felted (2" thick)	94.0	94.2	94.3	94.4	94.5	94.5	94.5	94.5
Cost of heat lost per year insulated flange	$.213	$.252	$.350	$.452	$.604	$.835	$1.048	1.345
Cost of insulation material and labor (approximately)	3.76	4.85	5.36	5.05	8.09	11.40	15.05	18.81
Annual charges, fixed (10 per cent)	.38	.49	.54	.60	.81	1.10	1.51	1.88
Net saving per year	2.96	3.78	5.25	7.03	9.57	13.25	16.50	21.23

Note: The above net savings apply only to 500 deg. Temperature Difference; Coal 13500 Btu.; $3.00 net ton. 60% Boiler Efficiency equals $.278 per million Btu.

Annual charges: Interest on investment, 5%; Depreciation, 5%. Year's operation, 24 hrs. 300 days per year, 7,200 hours.

wall opposite the tubes in the first pass. The wall on one side of a baffle is much hotter than it is on the other. With insulation at the outer surface this change is very much less abrupt and the tendency toward cracking of the wall is correspondingly decreased. On the other hand, insulation between two portions of the wall tends to accentuate the differences in temperature and the differences in expansion in these parts.


Note: Each tank car contains 10,000 gals. of water
10,000 gals.
WATER:- The water in these twelve tank cars is needlessly evaporated each year if the steam line shown in red is not covered.
10,000 gals
150 lb press
Steam in main at 150 lb. = 368°F
100' of 5" uncovered pipe Air assumed at 70°F
Boiler
Feed water heater
Feed pump
Steam separator
Engine
High pressure trap
40 tons coal
COAL: The coal in these cars can be saved each year by covering the steam line shown in red

A comparison of insulation losses.

4. Insulation on the outside of the wall prevents excessive cooling of the wall when fires are banked or, in the case of oil fired boilers, when the boilers are standing by with only enough oil fire to keep steam up. Therefore, boilers will respond more quickly when steam is required. It has been found, in the case of oil fired boilers where subject to sudden demands, that walls, with insulation on the outside, stand up better than those without insulation. If the wall is allowed to cool by radiation, sudden heating has a tendency to cause the brick to spall.

LOSSES THROUGH FLANGE UNIONS BY RADIATION

Pipe. Size In.	O.D In.	Thick In.	Width Face In.	Area Sq. In.	Area Sq. Ft.
4	9	15/16	2½	155	1.1
6	11	1	2½	203	1.4
8	13½	1 1/16	2¾	275	1.9
10	16	1 3/16	3	366	2.5
12	19	1 ¼	3½	490	3.4
16	23½	1 7/16	3¾	678	4.7
20	27½	1 11/16	3¾	853	5.9
24	32	1 ⅞	4	1086	7.6

BTU. LOSS PER HOUR PER BARE FLANGE

Temp. Dif.		300°	350°	400°	450°	500°
Btu. loss hr. sq. ft.		978	1269.4	1614	2050.6	2590
Size	Area Sq. Ft.					
4"	1.1	1067	1396	1775	2256	2849
6"	1.4	1369	1777	2260	2871	3626
8	1.9	1858	2412	3067	3896	4921
10	2.5	2445	3164	4035	5127	6475
12	3.4	3395	4316	5488	6972	8806
16	4.7	4597	5966	7586	9638	12173
20	5.9	5770	7489	9523	12099	15281
24	7.6	7433	9647	12266	15585	19684

(Continued on page 455)

The Development of America's Future Power Supply*

The Foundations for More Comprehensive Method of Generating and Distributing Now Laid—Super-Power Will Revolutionize Our Civilization.

By GEN. GUY E. TRIPP†

IN striking contrast to all other public utilities, the electric light and power industry, I am convinced, is about to enter into a new era of development. The railway, telephone, telegraph and gas industries have become settled enterprises. They will continue to grow as the country grows and will from time to time improve their methods; but in all probability none of them will be called upon to furnish a radically new kind of service to meet the increasing requirements of our highly organized social life.

Gen. Guy E. Tripp

But with electric power the case is quite different. Power is the basis of civilization. Without it, man could not have emerged from barbarism. Nor can we make any marked progress except when notable improvements are made in our power supply. Thus the power of slaves gave us one type of civilization; draft animals, a second; steam engines, a third; and so we have advanced, step by step, until we are today living in an age characterized by electric power supplied by individual central station companies.

We shall not stop here, however. Already, we are laying the foundations for a new and more comprehensive method of generating and distributing power. An increasing number of our water powers are being developed and new steam plants of the largest size constructed. Because of certain economic advantages, with which all engineers are familiar, the tendency is to connect groups of these plants together, forming large composite systems. By its very nature, a composite system can produce power at a lower cost, and therefore can sell it at lower rates, than an isolated local company. Hence when its lines reach the territory of a local company, the latter will be unable to compete and must eventually become a part of the larger system. The growth of these composite systems will, therefore, be irresistable, until in time a few "super-power" systems, drawing upon all economical sources of power within the areas they cover, will supply electric energy to the greater part of the North American continent. Even the splendid companies serving the metropolitan areas will in all likelihood join the super-power systems, because they will then be able to turn their surplus power into the common reservoir for general use and can draw from the same reservoir such additional power as they may require in emergencies.

This abundant and widely distributed supply of electricity, which will thus be furnished by the super-power systems, will confer innumerable benefits upon the people of the United States and Canada. It will increase the productiveness of farms; improve transportation; reduce the cost of manufactured products; promote mining and metallurgical operations; increase the effectiveness of human labor; conserve our diminishing fuel resources; and, by providing ample facilities for industry and for comfortable living in the open country, it will draw the people out of the congested cities. In a word, it will so enhance our welfare that it will usher in a new era in the history of civilization.

But because super-power systems will become vital to our national prosperity and must, of necessity, be monopolies, they will be shining marks for the advocates of government ownership. The efforts of these earnest theorists will be multiplied exceedingly, and we shall but deceive ourselves if we believe that their doctrine will be unheeded by the public and the politicians.

It so happens, however, that regardless of the merits or demerits of the theory of the public ownership of the utilities as an abstract proposition, the government ownership of a super-power system is entirely impracticable. There are three possible kinds of government ownership—municipal, state, and national. Obviously, no municipality can properly own any part of a power system that extends and carries on trade far beyond its boundaries, and is interstate, and even international, in character. Nor, for exactly the same reason, can a state. Super-power systems must ignore political boundaries; and any attempts to keep their lines within arbitrarily chosen limits

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*An address before the convention of the National Electric Light Association, June 6, 1923.

*Chairman of the board, Westinghouse Electric & Mfg. Company, New York City.

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will merely result in destroying them as super-power systems and depriving the public of the chief economic advantages that they confer.

National ownership, on the other hand, may at first sight seem entirely feasible, but analysis shows that great difficulties exist here also. In the first place, the authority of the Federal government does not extend beyond national lands, boundary waters, and navigable rivers. It could not, under present laws, control the power developed by non-navigable streams, to say nothing of the necessary steam plants. Any attempt on the part of the Federal government to extend its control would be promptly resisted by the states with the support of public opinion, which sees the danger to our republic in the growing tendency of the Federal authorities to interfere in local affairs.

But, assuming that suitable legislation were to eliminate these political obstacles, many more of a different nature would still be left. No one seems anxious for the government to reassume control of the railroads nor continue that of the merchant marine. Yet, in comparison with the management of a super-power system, the management of these industries is simpliciy itself. These industries are fully matured; they offer only one service to a few classes of customers; and all of their methods have been carefully standardized. A super-power system, on the other hand, will serve hundreds of classes of customers in innumerable ways. It will not only receive power from hydraulic and steam plants, but from every other possible source, including that derived from the by-products of manufacturing operations, such as the gases from blast furnaces and coke ovens, the residues left after the extraction of gasoline from coal, and, especially, many future possibilities about which we now know little or nothing. Then, too, the electric power industry is far from maturity. We have every reason to believe it will triple or even quadruple its present growth within 15 years. Every day sees new uses for electricity, and no one can foresee what we shall be doing with this marvelous force 10 years from now. Is the deadening hand of the government the proper one to guide so vigorous and promising an infant on its way?

But assume again that this difficulty was overcome, and that the government was able, in some extraordinary manner, to operate such a complex business with acceptable efficiency. Even then there would be no super-power system worth the name. And for this reason: A super-power system, to serve the public in the most effective and economical manner, must supply power for all purposes and particularly to those users who consume it in immense quantities. But no great industry would dare risk its future by depending on a government-owned system for its power, because the contracts of any government-owned agency can be nullified by political action.

Therefore, if the nation is to have super-power systems, they must be built by private capital and operated by private companies. Government ownership in any form would be fatal to their development and disastrous to the best interests of the public. Consequently, it is to be hoped that there will be no further movement in that direction. Each new municipal plant that goes into operation and each new obstructive state law, like that of Maine prohibiting the export of water power, presents one more obstacle to the completion of the general plan. It is most pleasing to note the broad-minded water-power policy of Governor Pinchot of Pennsylvania, and it is encouraging to remember that the New York State legislature did not adopt a policy of hoarding the state's water power. But, nevertheless, there is altogether too much sentiment in favor of the government ownership of electric light and power utilities, and especially of water powers; and the growth of this sentiment can only be stopped by making the people clearly understand the fundamental fallacy involved in it, and by proving, through service, that private ownership and operation is, from the standpoint of the public, the better way.

But because through force of circumstances the electric power industry is called upon to provide America's future power supply, it would be an unpardonable error if the industry viewed this opportunity in the light of a special privilege. Rather, it is a great and pressing obligation—on the one hand to prevent the people from committing themselves to a calamitous policy, and on the other, to provide the means that will bring about the maximum of prosperity.

To carry out this obligation, expeditiously and efficiently, co-operation is required in greater measure than this, or any other industry, has ever seen; co-operation within the industry and co-operation with the public. As the existing companies become transformed from isolated enterprises, serving local needs, into great unified systems, serving the nation, ample opportunities for differences of opinion and conflicts of interest will arise. Some means must be found within the industry for formulating general policies and for promptly adjudicating dissensions; for unless this is done, progress will be hampered, and the impression will go abroad that the government alone can do the necessary work.

Steps must also be taken to establish the fundamental principles for the regulation of super-power systems. Though these systems are unsuited to public ownership and operation, they must nevertheless be subject to public control. However, the less restriction there is to rightly directed private initiative, the better. It is, herefore, highly desirable to determine as soon as possible the irreducible minimum of regulation that will afford complete protection to the public and at the same time promote electric power development to the greatest possible extent.

The electric light and power industry is undoubtedly about to enter a new era of development, which will be characterized not only by great technical achievements, but also by the establishment of a new order of relationships both within the industry and with the public. This development can take place under private initiative with government regulation, but not under government ownership. If the people insist on government ownership, they will deprive themselves of the full benefits of the resources which nature has given us. And surely, private ownership under public control is not only the better, but also the safer method. If the people cannot trust their representatives to regulate the electric power industry, how can they trust them to own and operate it?

The Department of Commerce announces the sales of mechanical stokers for 1923, by months, according to returns made to the Bureau of the Census, as follows:

Month.	Number of establishments reporting.	Stokers sold.		Installed under Fire tube boilers.		Installed under Water tube boilers.	
		No.	Hp.	No.	Hp.	No.	Hp.
January	15	145	83,270	29	3,400	116	79,870
February	15	129	66.619	9	1,172	120	65.447
March	15	120	68.955	9	1,259	111	67,696
April	15	167	85.339	14	2,000	153	83,339
May	15	194	100,513	14	1,915	180	98.598
June	15	135	59.719	6	804	129	58,915

The Ljungstrom Air Preheater

America Is Now Following Europe's Lead—Locomotive Practice Applied to Central Stations.

THE greatest source of loss in connection with steam boiler operation is the quantity of heat carried away to waste by the flue gases. The days have long passed in which a high exit temperature of the gases was tolerated for the sake of producing natural draught and economizers are fitted in all plants of any importance in order to utilize as far as possible the heat which the boiler itself cannot extract from the gases. The close regulation of the excess air supply to the fires which is rendered possible by the use of CO_2 recorders has had its natural effect in increasing the temperature of the exit gases, and this again has called attention to the amount of recoverable heat which these gases contain. In addition to extracting a part of this heat by means of economizers, or indeed as an alternative to the use of economizers, it has often been proposed to use the heat of the waste gases to raise the temperature of the air supplied to the fires.

Furnace efficiencies have been successfully raised nearly to par values; the major furnace losses now recorded remain as radiation.

The heat-balance points directly to the up-stack loss as the great offender. Any method which transfers temperature from the exit gases to the entering air for combustion performs a double purpose and compounds its results. The economizer was a logical step, but is indirect in its action.

The air-preheater is the conclusive trend. The accompanying table of test results secured from an English operation indicate what may be expected when this simple device is applied to our huge modern power units.

The practical benefits of doing this are claimed to be greater than one would deduce from simple arithmetical calculations. The advantage does not stop with the mere return of so many heat units per hour to the furnace. The hotter air supply naturally increases the furnace temperature, and consequently increases the rate of radiant heat transmission to the boiler in a much greater ratio. This increased rate of heat transmission also has the effect of reducing the flue gases leaving the boiler to a temperature actually lower than they would have been had the furnace been supplied with colder air.

The proper solution of this problem has been receiving the attention of engineers throughout the world for years, since with the resulting advantages so fully understood, it has been generally appreciated how far-reaching would be any invention along the lines desired which would permit of ready application, be reasonable in first cost and at the same time be simple and reliable in operation.

Such a device would have the effect of increasing materially the overall efficiency of any boiler plant due to the recovery of a high percentage of the heat contents of the waste gases. The actual efficiency of the boilers would be increased in consequence of the higher temperature of the combustion gases, causing a higher rate of heat transmission within the boilers, the evaporative capacity of which would also be improved. Low grade fuels could be utilized successfully since the hotter air supplied would accelerate the chemical reaction of combustion and bring about a livelier and more complete burning of the fuel. The use of such an apparatus in preference to the employment of the economizer would leave open the possibilities of utilizing fully the exhaust steam from auxiliaries or from manufacturing processes for the heating of the feed water, to say nothing about reduced building costs and other advantages such as draught regulation which might be expected to ensue dependent on the design followed in the development of so comprehensive an apparatus.

Up to the present, there are two ways by which it has generally been attempted to raise the temperature of air for combustion. In steel works' furnaces, a common practice is to pass the fresh air and the flue gases alternately through regenerating chambers, so that the incoming air picks up heat from the brickwork previously raised to a high temperature from the passage of the flue gases. For boiler furnaces the flue gas temperature is not sufficiently high to make this plan practicable, quite apart from the difficulty of carrying it out. Hence when regeneration has been applied to steam boiler plants it has been customary to transmit the heat from the waste gases to the incoming air, through metallic surfaces separating the air passages from the flues. Heat transmission under such circumstances is not very effective, as the temperature difference is not great and the surfaces of the heating device are prone to become covered with a layer of soot or tarry matter which acts as a non-conductor.

The third solution, in the form of the Air Preheater which has been designed by Mr. Frederick Ljungstrom of Stockholm, Sweden, whose originality and fertility of mind have been demonstrated in the design of the Ljungstrom Steam Turbine and Turbo-Locomotive, would seem to be the ideal solution and hence a noteworthy contribution to present-day achievements in the field of engineering.

This air preheater, of which an external view is shown in Fig. 1, is unique in that it embodies neither of the prinicples referred to above, but carries heat continually in a mechanical way from the flue gases to the incoming air. It will further be observed that the apparatus is so designed as to be compact, simple in operation and permits of ready application either to existing boiler plants or new installations.

Fig. 1 illustrates diagrammatically the internal arrangements.

Referring to the diagrammatic figure fresh air is drawn by a fan into the upper portion of the casing, which is divided into two parts by a vertical partition.

The air is confined to one side of the partition and passes downward to a similar semi-circular chamber, through the body of a porous cylindrical drum or rotor.

The flue gases from the boiler traverse the apparatus in the reverse way, entering the lower semi-circular chamber and passing upward through the rotor to the upper chamber, whence they are exhausted and impelled to the stack by another fan.

The integral fans are carried on a common shaft and the required speed of the rotor—about six revolutions a minute—is obtained by means of suitable gearing connecting the fan shaft with the driving motor.

The rotor is kept in a state of continual slow rotation so that the part heated by the flue gases is continually passing to the other side of the device and gives up its heat to the cold air sweeping through it. Similarly, of course, the cooled part of the rotor is continually returning to be re-heated by the flue gases.

It will be observed that there is no transference of heat through metal in the process. A deposit of soot or tarry matter does not therefore have any very serious effect upon the action of the apparatus, which moreover may be cleaned in a few moments by means of a steam jet.

This latter blows the soot along with the air going to the furnace so that what heat value it has is returned to the fire.

The rotor which is illustrated separately in Fig. 3, is built of thin sheet steel and divided into sections by radial plates, which serve as stiffening spokes. In each section the heating elements are placed concentrically. These consist of specially corrugated plates alternating with plain, thus forming, when assembled, a great number of passages and resembling a honeycomb structure. It will be appreciated that this design allows a very liberal heating surface to be provided in a heater of comparatively small dimensions and with very little obstruction to the passage of the gases and air.

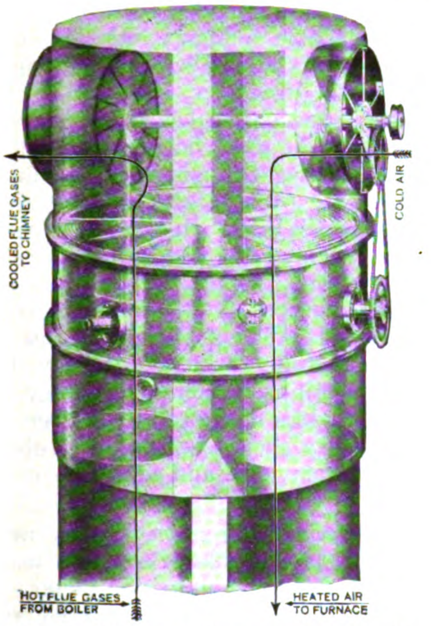
COOLED FLUE GASES TO CHIMNEY
COLD AIR
HOT FLUE GASES FROM BOILER
HEATED AIR TO FURNACE

FIG. 1—*Phantom view showing interior arrangement of preheater with directions of flows, etc.*

On the outside of the rotor a heavy steel ring is fastened, against which the carrying and guide rollers are working. As the rollers carrying the weight of the rotor are mounted on ball bearings the amount of power required for driving purposes is insignificant.

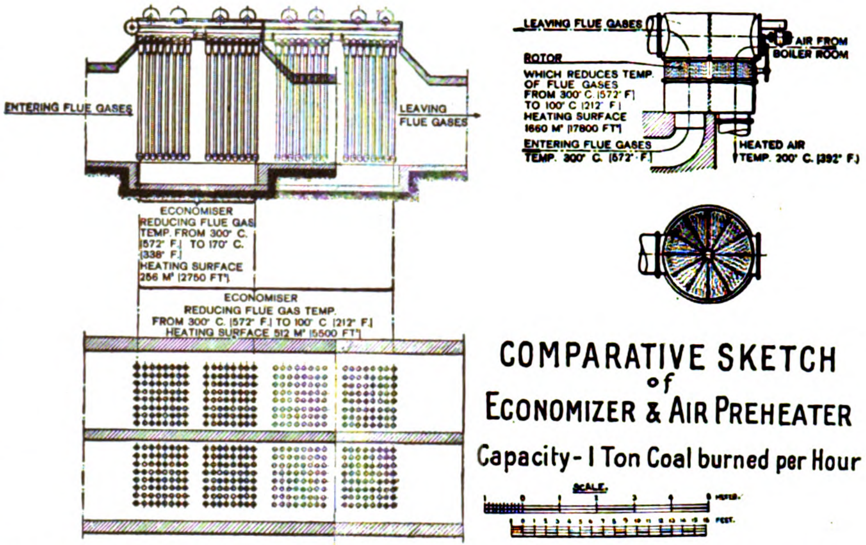
ENTERING FLUE GASES
LEAVING FLUE GASES
ECONOMISER
REDUCING FLUE GAS TEMP. FROM 300° C. (572° F.) TO 170° C. (338° F.)
HEATING SURFACE 256 M² (2750 FT²)
ECONOMISER
REDUCING FLUE GAS TEMP.
FROM 300° C. (572° F.) TO 100° C (212° F.)
HEATING SURFACE 512 M² (5500 FT²)
LEAVING FLUE GASES
AIR FROM BOILER ROOM
ROTOR
WHICH REDUCES TEMP. OF FLUE GASES FROM 300° C. (572° F) TO 100° C (212° F)
HEATING SURFACE 1660 M² (17800 FT²)
ENTERING FLUE GASES TEMP. 300° C. (572° F.)
HEATED AIR TEMP. 200° C. (392° F.)
COMPARATIVE SKETCH of ECONOMIZER & AIR PREHEATER
Capacity - 1 Ton Coal burned per Hour
SCALE.
METERS.
FEET.

FIG. 2—*Shows the relative performances to be expected from economizer and preheater on a one-ton basis.*

Incidentally as friction drive is employed, this precludes the possibility of trouble resulting from contraction or expansion.

It is claimed that as an alternative to an economizer, the Ljungström air preheater is not only more efficient, but is somewhat lighter, and less expensive in first cost and maintenance. Fig. 2 shows an air preheater designed to deal with the flue gases from a steam plant burning one ton of coal per hour, as compared with an economizer of standard design intended for the same duty. In both cases it has been assumed that the temperature of the flue gases leaving the boiler is 572 deg. F. The air preheater cools the flue gases down to about 212 deg. F., thus absorbing the heat between these limits which, according to tests, results in a saving of fuel of 20.1 per cent. The weight of the heating element is 7100 lbs.

If it were possible for the economizer to absorb the same amount of heat, its dimensions would become those shown in full drawn plus shaded lines. In practice, however, its dimensions would actually be as shown by the full lines alone, with the result that the flue gas temperature would only be reduced to about 338 deg. F., the calculated saving in fuel would be 8.6 per cent, and the total weight of tubes would approximate 44,000 lbs.

For marine boilers, the Ljungstrom Air Heating System is particularly well adapter on account of the great amount of regeneration which can be effected by an apparatus of very moderate size and weight. In such cases, the air preheater is placed on top of the boilers directly abaft the funnel and the necessary connections for flue gases and heated air are made in such a manner that the preheater can be by-passed if necessary when getting up steam.

In marine installations, the saving in fuel brought about by preheating the combustion air is greatly augmented by the attendant saving in bunker capacity and the number of boilers required which, of course, has the effect of increasing the carrying capacity of the ship.

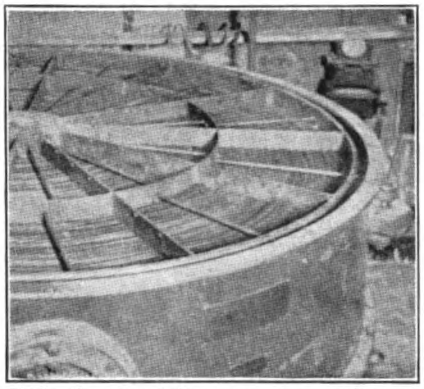

FIG. 3—*Revolving member which allows a very liberal heating surface in a comparatively small dimension—without obstruction to flow currents.*

The Howden-Ljunstrom Patent Air Preheater.

Summary of test figures obtained from cylindrical type Marine boiler, fitted with Howden-Ljungstrom air preheater, at works of James Howden & Company, Ltd., Glasgow.

Two furnaces 31⅞ in. diameter, grate area 24 sq. ft. Total heating surface with coal, 910 sq. ft. Total heating surface with oil (bars removed) 1,036 sq. ft. Retarders in tubes.

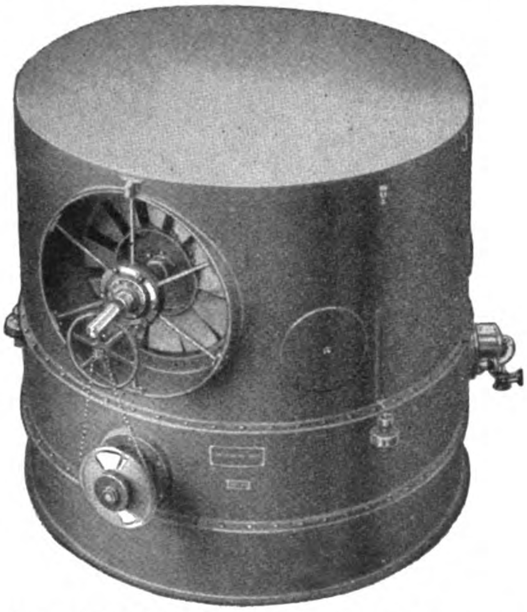

FIG. 4—*Outside view of complete air preheater.*

Conditions	Coal Burning		Oil Burning	
Date	31/1/23	14/2/23	5/3/23	6/3/23
Duration — hours	5	4	4	4
Steam press, lbs./sq. in.	164	167	161	161
Average feed temp., °F.	180	165	179	172
Class of fuel	Scotch Coal	Scotch Coal	Mexican Oil	Mexican Oil
Calorific value of fuel—Btu.	13,055	12,300	17,574	17,574
Fuel burned per hr.—lbs.	540	636	453	495
Equiv. evap. per lb. fuel lbs.	11.12	10.19	15.97	15.76
Equiv. evap. sq. ft. H.S.—lbs.	6.6	7.12	6.99	7.54
Temp. of flue gases entering air preheater—°F.	538	561	537	554
Exit temp. flue gases —°F.	217	231	195	215
Temp. air entering fan —°F	76	66	77	77
Temp. air leaving preheater — °F.	419	427	426	427
Temp. air entering furnaces — °F.	405	415	398	409
Air press. in reservoir around furnaces ins. W. G.	0.35	0.34	0.31	0.32
Air pressure at furnace door—ins. W. G.	0.06	0.02	0.16	0.15
Air press. at ashpit door—ins. W. G.	0.30	0.30	0.24	0.23
CO^2 in flue gases—%	9.5	9.0	11.1	11.0
Gross thermal effic. of boiler	84.36	85.49	87.6	87.13
Net thermal efficiency of boiler	88.82	86.93	90.5	91.3

*Metering Three-Phase Power Supply**

By G. W. STUBBINS, A.M.I.E.E., A. Inst. P.

The large number of consumers whose demand for power is of the order 100-200 kw. supplied on the three-phase system, renders the question of metering one of importance. In the case of larger undertakings methods of metering three-phase supplies are standardized, but a review of the available methods may be interesting to those connected with the smaller undertakings in which individual demands for over 100 kw. of three-phase power are uncommon.

In the first place it must be noted that the question of the cost of metering equipment is of much less importance in the case of a large consumer than in that of the small domestic load. In the latter case the cost of the meter is often of the same order as the amount of the yearly revenue, while in the case of the large power consumer the cost of the metering equipment is relativley trifling. It follows, therefore, that whereas in the case of the domestic consumer it may be a good proposition to sacrifice extreme accuracy and use a cheaper meter, this does not apply with large power supplies, when no money should be spared to obtain permanent and high accuracy, ease and simplicity in testing and connecting.

The various methods of metering may next be considered in detail. The most obvious and usual method is by the use of a polyphase induction meter. Since private supplies are, or ought to be, metered on the low-tension supply when the service mains are high tension, two current transformers are all the additional apparatus required. The advantages of the polyphase meter are that it gives a direct record of the consumption and it is the cheapest. Polyphase meters are, however, difficult to test within narrow limits of accuracy, especially so when operated with series transformers. Mistakes can also be made in connecting up which may seriously impair the accuracy of registration. These defects require serious consideration, especially in the smaller undertakings where the testing facilities are not very good, and such defects have been largely instrumental in securing wire adoption of other methods which, if not so advantageous as regards initial cost, yet give promise of more prolonged accuracy.

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*Electricity.

The polyphase meter consists of two single-phase elements assembled in one case, each element driving a single rotating member. An obvious alternative to the use of this instrument is to use two separate single-phase meters. The advantages of such a system are very considerable. The single-phase meter has a higher inherent accuracy than the polyphase instrument in that it has a lighter rotor. Each meter, moreover, is immune from the influence of the other, this not being the case with the two element meter, in which interaction between the two elements is a source of error. There is far less chance of wrong connections with two single-phase meters, as forward rotation should be obtained in both meters on lagging power factors down to 0.5. If the meters are accurately adjusted for quadrature, either can be connected in the leading or lagging phases indifferently.

A good approximation to the average power factor can be obtained from the ratio of the readings (m), if the circuit is fairly balanced, from the formula:

$$PF = \frac{1}{2}\,\frac{m + 1}{\sqrt{m^2 - m + 1}}$$

Alternatively, if the average power factor be known approximately, the total consumption can be estimated should one meter fail.

The disadvantages of the two-meter method are the higher cost, and the fact that unequal records are obtained on the two meters for inductive loads. This latter circumstance has been found to raise doubts in the minds of consumers as to the accuracy of the meters, it being assumed that the meters should show equal consumptions. Regarding the question of cost, it may be noted that with the two-meter method one single-phase meter would be carried spare for each polyphase meter where these were in use.

It is hardly necessary to say that each meter of a two-meter combination is tested as a single-phase instrument, whereas this procedure is not legitimate with a two-element meter unless special precautions are taken. On the score of ease of calibration there is a very great advantage with the two-meter method, and the cost will be under 50 per cent greater than that of the two element meter scheme.

The disadvantage of unequal registrations on the two dials of the two-element method that has been referred to above has been responsible, on some undertakings, for the use of three single phase meters for large three-phase supplies. These are designed for the star voltage, the potential coils being connected Y fashion, the star point being joined to the low tension neutral if this be available. It may be noted that it is not absolutely necessary to do this as the combination will meter correctly with a free neutral. By using three meters approximately equal records are obtained on each instrument, the method is fairly self-checking, forward registration is obtained at all power factors, and if the star point is connected to the supply neutral the combination is accurate for unbalanced four-wire lighting loads. Although the cost is certainly higher than each of the foregoing methods, the registrations are much more satisfactory from the consumer's point of view. To secure maximum accuracy three series transformers should be used, each meter being calibrated in conjunction with its own transformer. The three series transformers will be interconnected four-wire on the secondary side.

The foregoing notes will serve to emphasize the fact that the cheapness of the polyphase meter is largely discounted by attendant disadvantages; and the benefits of the two or three-meter methods are commended to those connected with small undertakings, in which ease of calibration and installation will probably be found an ample set-off against the slighty increased initial cost.

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Insulation in Power Plants

(Continued from page 449)

In summing up, it may be said that the savings by insulation in power plants are very large and that the modern tendency toward higher pressures and higher superheat has made the use of adequate insulation all the more essential.

Furthermore, the savings by insulation are definite and assured and the money invested in insulation is paid back many times by the savings. Other losses can, of course, be greatly reduced by careful operation of the plant, but efficient insulation stops the leaks which efficient operation alone cannot touch. The savings by insulation are wholly in addition to the other savings which may be effected by other means.

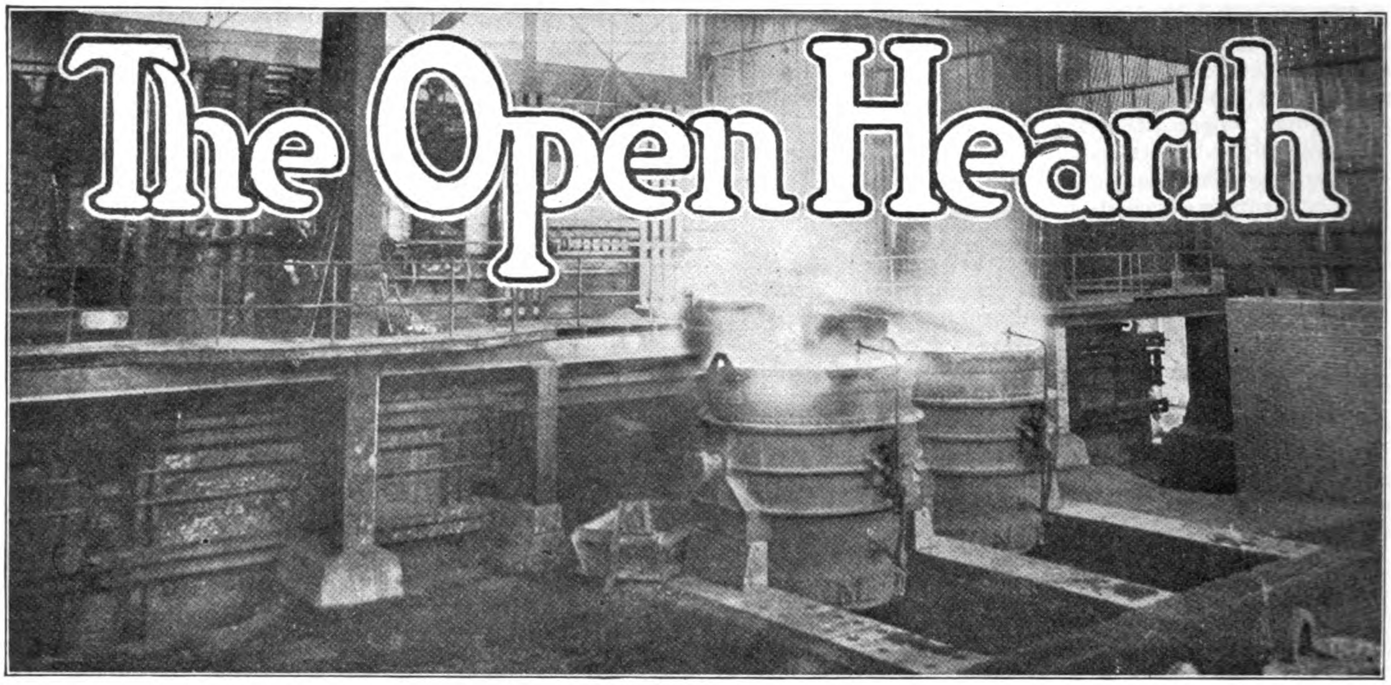
Bethlehem Plant Buys Reversing Motor

A double unit reversing motor has been purchased for the Lackawanna plant of the Bethlehem Steel Company at Buffalo, N. Y., which plant was recently acquired by the Bethlehem Steel Company. The motor replaces a steam engine and will be used to drive a 40-inch reversing blooming mill. The consideration was about a quarter of a million dollars. The installation will be made by the Westinghouse Company.

The continuous rating of the motor is 7,000 hp. at 50 rpm., and it is built to withstand peaks of 19,000 hp. The speed ratings range from 0 to 120 rpm. When installed, the motor will be supplied by a flywheel motor generator set, consisting of two 3,000-kw. generators and a 3750-hp. motor, and a 100,000-lb. flywheel.

The contract includes all control equipment and switchboards.

The Open Hearth



C. A. Meissner of Pittsburgh, who supervised construction of the new by-product coke plant for the Koppers Construction Company for installation at the Weirton Steel Company, Weirton, W. Va., has been made superintendent and Casey Evans of Steubenville, Ohio, has been appointed his assistant.

Henry B. Mayo, chief engineer for the Ford Motor Company, Detroit, and personal representative of Henry Ford in all the latter's large projects, has been appointed general manager of the Detroit street railways, which are municipally owned. He succeeds the late Joseph A. Goodwin.

Robert E. Newcomb, manager of the Dean works of the Worthington Pump & Machinery Corporation, Holyoke, Mass., has been appointed chairman of a Massachusetts central-western coal storage committee to function in Hampden, Hampshire and Franklin counties relative to coal storage problems. A. B. Reynders of the East Springfield, Mass., plant of the Westinghouse Electric & Mfg. Company, is also a member of the committee.

T. B. Bechtel has been appointed assistant chief engineer of F. J. Ryan & Company, Philadelphia. Mr. Bechtel, who has been with the Ryan company since its inception, has had many years of experience in the industrial heating field, especially in the design and development of apparatus and equipments incidental to electric furnaces.

F. H. Rood has been appointed engineer of tests for the Pittsburgh Testing Laboratory, Pittsburgh. He is a graduate of Syracuse University and for many years was engineer of tests for the New York State Highway Commission. For three years he was assistant engineer of tests for the Pittsburgh Testing Laboratory, and for two years research engineer for the United States Bureau of Public Roads.

Thomas H. Endicott recently was named vice president and general manager of the Green Equipment Company, Chicago. He formerly was sales engineer for the Crocker-Wheeler Company and later sales manager for the E. C. Atkins Company. Recently he organized a company to serve as a consulting engineer to industrial companies.

Armand J. P. Vandermyn has been elected president of the Industrial Paint Company, Pittsburgh, of which he has been vice president and general manager. Howard B. Charles has been appointed secretary and treasurer of the company. He formerly was general purchasing agent for the McClintic-Marshall Company, Pittsburgh.

R. Dill has been elected treasurer of the Allis-Chalmers Manufacturing Company, Milwaukee, succeeding the late Henry Woodland. Mr. Dill formerly was assistant secretary and assistant treasurer of the company. He has been succeeded as assistant treasurer by D. A. Stewart and as assistant secretary by J. A. Keogh.

Arthur Balfour, director of Arthur Balfour & Company, Ltd., Capital and Dannemora Steelworks, Sheffield, Eng., has been created a Knight of the British Empire in recognition of his distinguished public services. Mr. Balfour is president of the association of British chambers of commerce and a member of the grand council of the Federation of British Industries.

James W. Whatley, for 20 years connected with the Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., in the general sales department, has been made general sales manager of the DeBardeleben Coal Corporation, Birmingham, recently organized.

Walter B. Enck, formerly operating as Walter B. Enck, Inc., with offices in the Pennsylvania Bldg., Philadelphia, has been appointed resident manager at the same address, for the Pioneer Coal & Coke Company, Oliver Bldg., Pittsburgh. He will handle the latter interests' sales in the territory in connection with Pittsburgh, Westmoreland, Youghiogheny steam, gas and by-product coal as well as standard furnace and foundry cokes.

Work has been started on construction of the first unit at the plant of the A. C. Williams Company foundry, Ravenna, Ohio. The first unit is a series of concrete pits above on which a railroad siding is to be laid so that cars can be run directly over them for unloading. The building will be used for the storage of sand and is to be of steel and concrete. Two additional structures will be erected this summer, plans for which now are under way.

The Timken-Detroit Axle Company, Detroit, will operate a large plant in Cleveland. Announcement to this effect has been made by Fred Glover, president of the company. The plan by which the company will invade Cleveland provides for the purchase of all common and preferred stock of the Standard Equipment Company of that city.

TRADE NOTES

The Carnegie Steel Company has bought two New Model Westinghouse underfeed stokers for their Mingo Junction, O., plant. These stokers will heat two 1,000 hp. boilers by burning Pittsburgh biutminous coal. The stoking equipment includes steam operated power dumping grates, extension sidewall tuyeres and automatic secondary fuel bed rams. Pittsburgh bituminous coal will be fired.

The Virginian Power Company, Maxwell, Va., has bought two new 850 hp. B. & W. boilers and two Westinghouse New Model underfeed stokers. Steam driven stoker agitators will be supplied to reduce the carbon in the refuse to a minimum and facilitate ash discharge. Extension sidewall tuyeres will be installed to supply preheated air which facilitates complete combustion of fuel bed gases.

The Ohio Public Service Company, Lorain, O., has purchased electrical equipment to control Westinghouse stokers, motors and operate clinker grinders. The stoker motor circuits are equipped with d.c. ammeters, shunts and protective panels. Shaft extensions are provided for the controllers. The clinker grinder motors are equipped with the same units.

The increased volume of steel business is reflected in the construction program of the Carnegie Steel Company at their Munhall, Pa., plant. Eight new 834 hp. Stirling boilers and eight New Model Westinghouse underfeed stokers will supply steam for steel production. The gradual increase in the steel business is reflected in the fact that this contract is the 12th repeat order of this plant for Westinghouse stokers. The new stoking equipment includes steam power refuse dumping mechanisms, nonclinkering extension sidewall tuyeres and automatic secondary ram fuel bed control adjusting mechanisms. Engberg vertical steam engines will drive forced draft fans. This plant uses Pittsburgh coal.

The Washburn Wire Company, New York City, is enlarging its boiler plant to meet increased demand for wire products. Two new 720 hp. fire tube Springfield boilers and two New Model Westinghouse underfeed stokers have been ordered. Both the stokers and Buffalo Forge fans will be driven by Westinghouse d.c. motors. The blowers and motors will be connected by Thomas couplings.

The Pennsylvania Railroad Company has placed the ninth repeat order for Westinghouse New Model underfeed stokers for their Altoona Works. Two new Heine 500 hp. boilers are also specified. American blower engines will drive the stokers while Westinghouse turbines will furnish air from the Sturtevant fans. Automatic regulators and balanced valves will also be installed.

A. W. Heinle, metal rolling engineer, Pittsburgh, has added new data to his self-explanatory charts on alloy steel guide round and other rolled shapes.

Calvin L. Jones, welding engineer of the Westinghouse Electric & Manufacturing Company, Atlanta, Ga., has been elected vice president of the American Welding Society. Mr. Jones has been elected for a two-year term and will be in charge of the activities of the society in the Southern Division.

W. A. Murphy, assistant purchasing agent, has been appointed purchasing agent of the Weirton Steel Company, Weirton, W. Va. He succeeds J. F. Newman, who resigned recently to go into business for himself in Pittsburgh.

Mason P. Rumney, vice-president Detroit Steel Products Company, Detroit, has been elected president of the General Association of Michigan Alumni. He was graduated from the University of Michigan as mechanical engineer in 1908, having specialized in metallurgy and chemistry.

Clarence S. Siebert, for a number of years with the Superior Sheet Steel Company, Canton, Ohio, has become affiliated with Waldo, Egbert & McClain, Inc., as special steel representative, being located at Buffalo.

J. B. McIntosh, formerly purchasing engineer of the National Lamp Works of the General Electric Company, Cleveland, has opened an office in the Keith Building, Cleveland, as purchasing and consulting engineer, under the name of the J. B. McIntosh Company.

The Metropolitan Edison Company, Reading, Pa. will install clinker grinders on two stokers at this new plant. The increasing capacity of this Edison plant is part of a general plan of expanding due to prosperity of the Metropolitan Edison Company.

The Roller-Smith Company, 233 Broadway, New York, N. Y. announces the appointment of Mr. H. D. Baker, 525 Woodward Ave., Detroit, Michigan as its representative in the state of Michigan. Mr. Baker will handle the Roller-Smith Company's lines of instruments, circuit breakers and radio apparatus in that territory.

Albert Kahn, 1000 Marquette Building, Detroit, Mich., architect, has been commissioned by the Ford Motor Company, Highland Park, Mich., to prepare plans for the erection of a new steel works at River Rouge, Mich., to be used for material supply for automobile production. The main structure will be one-story 95x1300 ft., with three adjoining sections, one 100x625 ft., and two each 100x420 ft. Another one-story building will also be erected, to be 55x775 ft. The plant, with machinery, is estimated to cost in excess of $1,000,000.

The Warren Steel Casting Company, 3400 Maury Avenue, St. Louis, Mo., will commence the rebuilding of the portions of its plant recently destroyed by fire with loss estimated at $45,000, including equipment The new structure is estimated to cost approximately a like amount. A list of machinery to be installed will be arranged at once.

TRADE PUBLICATIONS

An eight page booklet, Special Publication No. 1667, containing a list of over 300 successful installations of Westinghouse industrial apparatus has been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The list, although containing only the more important installations and omitting, therefore, a great many of considerable interest, is impressive because it gives a definite idea of the extent to which electricity is being used for industrial heating purposes and shows that electricity is not simply the fuel of the future, as is often supposed. A few of the industries making use of electric heat are manufacturers of abrasives, manufacturers of airplanes, brick plants, bakeries, furniture factories, foundries, hospitals, railway companies, restaurants and cafeterias, rubber mills, steel mills, textile machinery manufacturers, textile mills, tool manufacturers, and wire mills.

COMING MEETINGS

August 20-30 — American Institute of Mining and Metallurgical Engineers. Meeting at Quebec, Canada. F. F. Sharpless, 29 West Thirty-ninth street, New York, is secretary.

September 10-14 — American Chemical Society. Fall meeting, Milwaukee. L. Parsons, P. O. box 1515, Washington, is secretary.

September 17 — American Ceramic Society. Fall meeting, Grand Central Palace, New York. R. C. Purdy, Ohio State University, Columbus, Ohio, is secretary.

September 17-22 — Chemical Industries. National exposition, Grand Central Palace, New York.

September 24-28 — American Association of Iron and Steel Electrical Engineers. Convention and exhibition. Auditorium, Buffalo. Headquarters of the association are located at 1007 Empire building, Pittsburgh.

September 27-29 — American Electrochemical Society. Annual meeting at Dayton, O. Dr. Colin G. Fink, Columbia University, New York, is secretary.

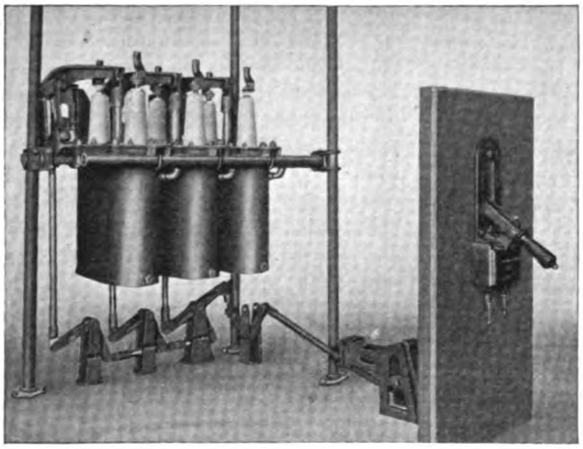
October 8-12 — American Society for Steel Treating. Annual convention at Pittsburgh. W. H. Eisenman, 4600 Prospect Avenue, Cleveland, is secretary.

WITH THE EQUIPMENT MANUFACTURERS

New Oil Circuit Breaker

A new oil circuit breaker, the type F-33, in capacities of 400, 600, and 800 amperes at 15,000 volts, has been placed on the market by the Westinghouse Electric & Manufacturing Company. This breaker has an interrupting capacity of 1,900 amperes at its rated voltage and is applicable wherever a breaker of that capacity is needed. It is made in the remote control form only to conform to the recommendations of the Electric Power Club oil-breaker standard practice rules limiting the service of panel mounting breakers to voltages not exceeding 2,500. A separate pole per frame construction makes it particularly applicable wherever it is desired to have the phases isolated.

The type F-33 breakers are supplied for either manual or electrical automatic or non-automatic operation and in single, two, three, or four pole units. Each pole unit is entirely separate with its own frame, mechanism, and tank. The heavy cast iron framework is arranged for either wall or pipe mounting. The mechanism of the breaker is provided with a toggle which permits the breaker to be adapted readily for upward, downward, or horizontal pull without the use of any additional material. A highly efficient form of wedge and finger contact is used with an auxiliary arcing contact on the moving element. The stationary contact is so shaped and located that different portions of the same contact surface act as the main current carrying contact and as the arcing contact, thus preventing arcing on the main contact surface. The sheet steel tanks have all seams lap-welded and are lined with micarta.



New oil circuit breaker.

The electric operating mechanism has a solenoid with a 3-inch diameter core and consists of a cast iron frame with spaces for closing and trip coils. The moving core of the closing solenoid pulls the main lever down to the closed position, where it is latched, and the trip coil disengages the latch. The mechanism is provided with springs to make the breaker open more rapidly. A two-pole, double-throw auxiliary switch is used for cutting out trip coil currents and controlling indicating lamps.

New Reversing Gas and Air Valve

Operating engineers are now giving much time and attention to the development of temperature control, and are demanding continuous refinements in furnaces, gas producing apparatus and devices for handling the gas, and carrying away the waste products, all with as much efficiency of combustion and loss of heat while maintaining proper and even temperatures.

A noteworthy advance is a combination of gas and air valve designed by W. G. Bergman, chief engineer for the Mc-Camic-Batchell-Berman Company, of Toledo, Ohio.

This valve is unique and practical in that the gas and air are reversed by the same operation and simultaneously, either by hand or automatically being controlled by clock works and motor or by thermostatic control; the thermostat being placed in the checker work of the regenerators. This latter is a most essential and valuable feature, and greatly facilitates the regulation of even temperatures.

The valve is circular in shape, being constructed of heavy sheet metal and lined with suitable brick. The gas which enters through the center passes into one of the six segements and then to a flue to the regenerators. The air enters from two ports situated in two of the six segements and spaced 120 degrees apart on either side of the gas segement. The air entering in one of the segements passes through an annular space, between the gas inlet and the waste gas segements, and then to the other air segement from, which it passes to the regenerators.

The waste gases enter the remaining two segements and thence to the stack.

The entire valve is water sealed and the duration of reversal is 10 seconds, during which time the valve passes through an angle of 120 degrees. During burning out periods the producer is connected directly to the stack, the air and gas ports being closed, and thus allowing no cold air to enter the furnace.

Characteristic advantages appear as follows:

1 A single hood reverses gas, air and waste gas.

2 All passage restrictions are eliminated.

3 All movable parts inside valve are omitted.

4 Leakage eliminated by water sealing all elements.

5 With stands abnormal temeperatures being lined with light refractory material.

6 Automatically operated by time-clock, thermostat, push-button or by hand.

7 Reliable and fool-proof, as gas, air and waste gas are reversed at one time.

8 Insures ideal combustion conditions.

DeLaval New "Series Pump"

A new style of centrifugal pump, called a "series pump," is described in a catalog just issued by the DeLaval Steam Turbine Company, Trenton, N. J. In this pump double suction impellers and volute diffusers are used, as in single stage centrifugal pumps. The connecting passages from stage to stage, however, are included in the pump case casting, as in the ordinary multistage pump. The advantages claimed are perfect hydraulic axial balance and high efficiency under varying loads, as is characteristic of the single stage pump. These series pumps are made with two or three stages. Where more than three stages are required, the use of two independent pumps operating in series and mounted on a single base plate is recommended in order to keep down the length of shaft between bearings.

Some Pointers on By-Product Coke Oven Operations

Comparison of Gas Masks, Hose Masks and Oxygen-Breathing Apparatus

Three types of respiratory apparatus — namely, gas masks, hose masks, and self-contained oxygen-breathing apparatus—are now commonly used for protection from noxious gases, vapors, and smokes or mists, but no particular type can be selected as best for all conditions. Many factors must be considered in connection with each situation, so that each much be considered as a problem in itself. Following are concise statements for comparing the types:

1. Gas masks are the simplest and easiest to wear, also the least cumbersome; but they protect only in comparatively low concentrations of noxious gases and should never be used where the air contains less than 16 per cent of oxygen. Special masks give protection from one gas or class of gases, but may give no protection against another gas or class of gases.

2. Hose masks protect in any irrespirable atmosphere, but are somewhat cumbersome, the length of hose limiting the distance a wearer may go from fresh air. They are serviceable also where a supply of pure air moves with the wearer, as where a locomotive engineer in a smoky tunnel is using a hose mask supplied with air from the compressed air line of the locomotive. Hose masks consume no chemicals or materials and so are not limited in the time they may be used.

3. Self-contained oxygen-breathing apparatus protect in any irrespirable atmosphere, but their weight is cumbersome, they can be used only by trained men, and frequent attentino must be given them to maintain good working condition. On the other hand they are the only safe means for exploring mines and other places filled with irrespirable gases in high concentrations.

The Department of the Interior advises that two or more men similarly equipped should always be present when a man enters an irrespirable atmosphere, regardless of the type of apparatus worn. Life lines should be attached to persons entering tanks and similar places and held, when it is possible to do so, by two or more observers to guard against accident.—Reports of Investigations, Department of the Interior, Bureau of Mines.

The following is a comparison of advantages and limitations of gas masks, hose masks, and oxygen-breathing apparatus:

Gas Masks

Gas masks do not protect against atmospheres deficien tin oxygen and should not be used therein. They serve only as filters for removing comparatively small amounts of irrespirable gas from air that is otherwise normal.

Gas masks with canisters containing 600 cubic centimeters or mpre of activated charcoal protect. The time of protection decreases rapidly as the concentration increases. Canisters containing gas absorbents other than activated charcoal are useless.

Gas masks do not protect sufficiently well in high concentrations of organic vapors (exceeding 5 per cent in air) to assure safety. They should not be used.

Gas masks with canisters containing 600 cubic centimeters or more of soda-lime or caustic soda fused on pumice granules protect. The time of protection decreases repidly as the concentration increases. Canisters of dry activated charcoal last only about 1/5 as long as soda-lime.

Gas masks do not protect sufficiently will in high concentrations of acid gases (exceeding 2 per cent in air), to assure safety. They should not be used.

The above mentioned gas masks containing lime, soda, and charcoal absorbents do not protect against ammonia. Special gas masks for the purpose are required. The 3 per cent maximum cannot be long endured by the wearer of the mask because of the severe skin irritation from ammonia gas.

Special gas masks containing Hopcalite which catalyzes the action of carbon monoxide with oxygen of the air to produce relatively harmless carbon dioxide, protect against carbon monoxide. They have some action on hydrogen sulphide and some other gases but can be considered safe for use only in carbon monoxide. The masks protect against concentrations exceeding 3 per cent but the intense heat produced cannot be long endured.

Hose Masks and Oxygen-breathing Apparatus

Oxygen-breathing apparatus protect against all deficiencies of oxygen, they are not dependent on surrounding air, hence they are vitally important in exploring and rescue operations in mines after explosions and fires.

Protect against any concentration that the skin will bear.

The first cost of gas mask apparatus varies from $15 to $50; hose masks cost about $75. From $160 to $225 is charged for the two-hour types of oxygen-breathing apparatus, and about $125 for the half-hour types. Accessories such as oxygen tanks and pumps may add to the expense.

There is no limit to the safe period of use of hose masks. With gas masks the safety period may range from about one-quarter to several hours or even days. Carbon monoxide masks are useful for only two to six hours. Oxygen-breathing apparatus are made in two sizes, rated for one-half and two hours minimum continuous supply of oxygen. When discharged they require renewal of oxygen and chemical charges.

The Bureau of Mines advises that two or more men similarly equipped should always be present when a man enters an irrespirable atmosphere in a tank or enclosed space, regardless of the type of apparatus worn. Life lines should be attached to persons entering tanks and similar places and held, when it is possible to do so, by two or more observers to guard against accident. In mine work, a crew consists of five trained men wearing oxygen breathing apparatus.

The results of this investigation are given in Serial 2489, by S. H. Katz, associate physcal organic chemist, and J. J. Bourquin, assistant chief mine safety engineer, which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

In addition to the Carburetted Water Gas Apparatus contract which it recently awarded to The U. G. I. Contracting Company, of Philadelphia, the Detroit City Gas Company has now awarded to that company a contract to furnish and install an 8-pass condensing system, which will be capable of cooling 1,2500,000 cu. ft. of gas per hour from 180 deg. to 90 deg. This condensing system will be installed with the water gas apparatus.

The U. G. I. Contracting Company, of Philadelphia, has received contract from the Northern Indiana Gas & Electric Company for the installation of a Compressor Building at the Ft. Wayne, Indiana plant and to install in the building a motor driven compressor, together with all gas connections necessary for the installation.

The Compressor will have a capacity of approximately 160,000 cu. ft. per hour at 25 lb. pressure.

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NEWS OF THE PLANTS

The National Enameling & Stamping Company, Granite City, Ill., has tentative plans under consideration for extensions in its open hearth department for considerable increase in production and will likely authorize detailed drawings prepared at an early date. The company has completed and placed its new steel plate mill in service, equipped for a capacity of 20,000 tons of material a month, handling plates 100 inches wide and from 1/8 to 1½ inches thick. It is expected to develop full production at the mill in the near future. Work is nearing completion on seven new sheet mills and these are expected to be ready for operation during August; the units will be fully equipped for maximum output and will be run on a full turn as soon as finished. The expansion program has called for an investment in excess of $1,200,000. George W. Niedringhaus is president.

The Connors Steel Company, Birmingham, Ala., manufacturer of strip steel and kindred products, is perfecting plans for the early rebuilding of the portion of its plant No. 1, destroyed by fire late in June with loss estimated at close to $175,000, including equipment.

The Columbia Steel Corporation, San Francisco, Cal., is pushing construction on its new steel works on site recently acquired in Utah. Foundations for the blast furnaces are being laid and superstructure work will be commenced at an early date. Work is also under way on other structures, including four hot stoves, warehouses and general shops. Operations at the iron ore properties are also progressing and it is expected that active mining will be commenced early in September. The company has consummated arrangements for taking over the Llewellyn Steel Company, and has acquired the entire capital stock. The Los Angeles plant, consisting of open hearth furnaces, rolling mill and other departments will be maintained in full operation. This acquisition gives the company three plants at San Francisco, Los Angeles and Portland, Ore., respectively. Pig iron from the new Utah blast furnaces will be shipped direct to all three of these mills.

The Bethlehem Steel Corporation, Bethlehem, Pa., has work nearing completion on enlargements at its works at Sparrows Point, Baltimore, Md., and expects to place the new departments in service in the near future. The additions include five new open hearth furnaces, constructed at a cost of about $2,500,000. The plant is now running at full capacity and will be maintained on this basis for some time to come. In the steel works, a total of about 6,500 men is being employed, while about 500 additional men are now engaged in construction work. This latter force will be gradually diminished as the different structures are completed. The company is not planning for any additional construction for the present and future enlargements, it is stated, will be governed by orders and general conditions.

The Hunter Crucible Steel Company, Cleveland, Ohio, has extensions and improvements under way at the local plant of the Electric Steel & Forge Company, Grant Avenue, recently acquired. Work is progressing on a one-story addition to the mill, to be 60 x 100 ft., with a 20-ft. extension on one side for shipping and inspection work. A new annealing furnace, car type, is being installed, as well as a 30-ft. crucible furnace. The plant will be converted for the manufacture of carbon tool steels and kindred products.

The Cleveland Structural Steel Company, 6600 Park Avenue, Cleveland, Ohio, has plans under way for the erection of an addition to its plant for increased production, consisting of a one-story and part basement structure, estimated to cost approximately $60,000, including machinery.

The Trenton Malleable Iron Company, New York Avenue, Trenton, N. J., has awarded a contract to S. W. Mather & Sons, Greenwood Street, Trenton, for the erection of a new one-story plant addition, estimated to cost close to $20,000, exclusive of equipment. Work will be placed in progress and the structure rushed to completion.

E. J. Lavino & Company, Bullitt Building, Philadelphia, Pa., are perfecting plans for the operation of their blast furnace in Virginia, known as the Ruesens furnace, and will place the unit in blast just as soon as necessary work has been completed at the stack. It will be devoted to pig iron production and it is proposed to develop maximum output at an early date.

The Inland Steel Company, Chicago, Ill., has active construction under way at its proposed extensions at Indiana Harbor, Ind., and expects to have a portion of the new mill ready for service late in the present year. It will consist of a number of structures and open hearth units to provide for about 25 per cent advance in the present plant output, and is estimated to cost in excess of $6,000,000, with machinery.

The Dodge Steel Company, Hellerman Street and the State Road, Philadelphia, Pa., has completed plans and will proceed with the erection of a new one-story addition to its plant for general increase in production. It is estimated to cost approximately $27,000.

The Wheeling Steel Corporation, Wheeling, W. Va., has disposed of a note issue of $8,000,000, a portion of the proceeds to be used in connection with plant extensions and improvements, covering for the most part the work which has been going forward for expansion during the past 18 months.

The Lancaster Iron Works, Lancaster, Pa., has construction under way on a number of new plant additions to provide for extensive increase in production. The work includes two new one-story structures, 55 x 106 ft. and 54 x 145 ft., respectively. A 10-ton traveling crane has been contracted for, to be installed in the last noted structure. All departments of the works are on a full time schedule, with employment of a large working force.

The American Puddled Iron Company, Youngstown, Ohio, recently organized with a capital of $3,500,000, will take over the plant and properties of the Youngstown Steel Company, Youngstown. The new company will proceed with the erection of the plant of the acquired company at Warren, Ohio, on which work has been under way for a number of months past, and it is purposed to have the structures ready for service in the near future. Up to the present time about $1,000,000 has been expended in construction work and an additional amount of this same size will be invested in accordance with plans as now laid out. The new organization is headed by John and Fred Tod, E. L. Ford and John Stambaugh, and will operate with a working capital of approximately $700,000, provided by recent financing.

The Railway Steel Spring Company, 30 Church Street, New York, N. Y., will commence the erection of a new addition to its plant at Latrobe, Pa., for which a general contract was awarded recently to the McClintic-Marshall Company, Pittsburgh, Pa. The work will consist of a main one-story structure, 175x1000 ft., and subsidiary buildings for steel-working, estimated to cost $350,000.

The Alabama Company, Birmingham, Ala., operating iron, coke, coal and other properties, has plans for the rebuilding of the portion of its mechanical plant at the Attalla, Ala., properties, recently burned

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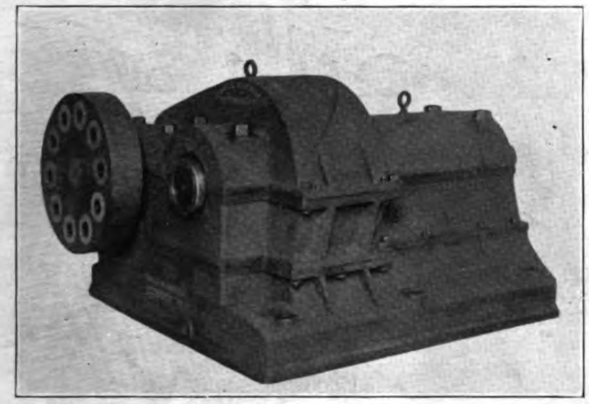

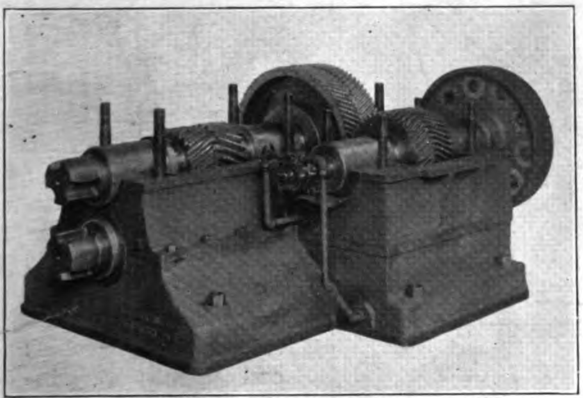

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This reduction is a recent development. The design confines in a single unit the transmission of power from the motor to the mill. The base plate of the pinion housing and gear reduction are cast solid, thus vibration is practically eliminated, and as a result wear, tear and maintenance costs are reduced to an absolute minimum. The saving of space and cost is apparent over separate pinion housing and gear reduction.

This gear reduction is part of a contract on which we furnished the largest Tandem Herringbone Gear Drive ever built for driving a 6 stand 16″ continuous bar mill, also one Tandem Drive for driving 4 stand 12″ continuous mill. All gear drives furnished with Fawcus Flexible Couplings for motor connections and Fawcus Universal and Fawcus Crab Thrust Collar Couplings for the mill connections.

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